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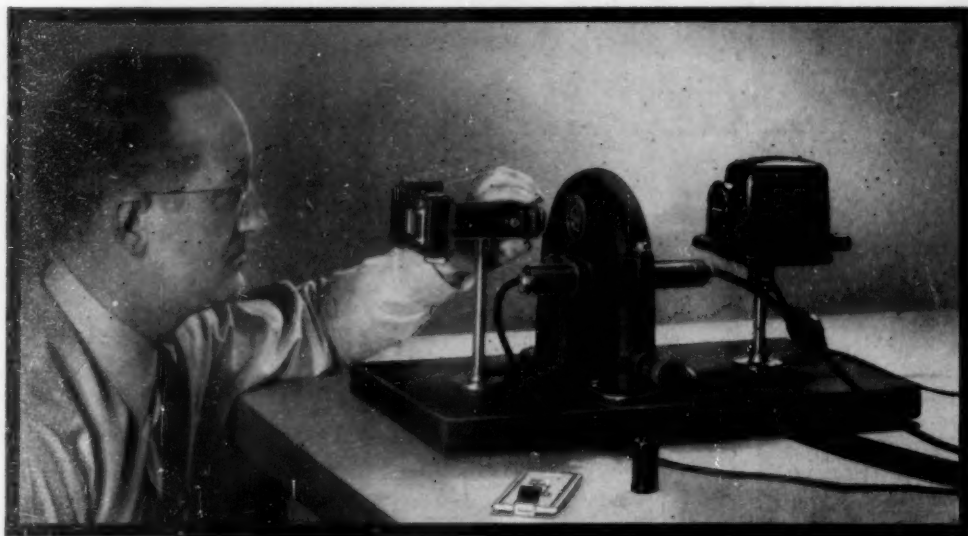
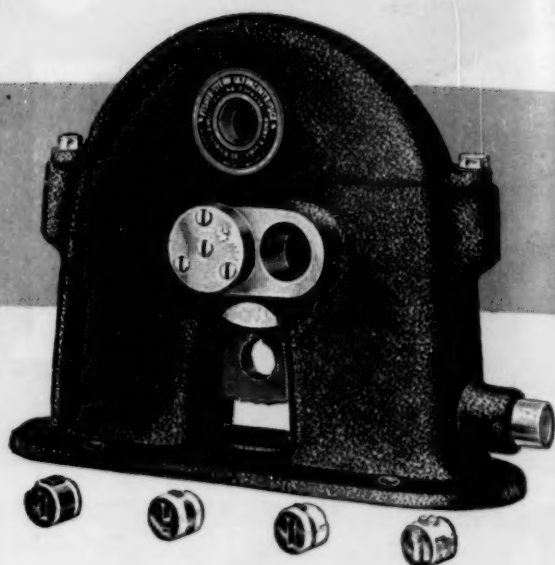
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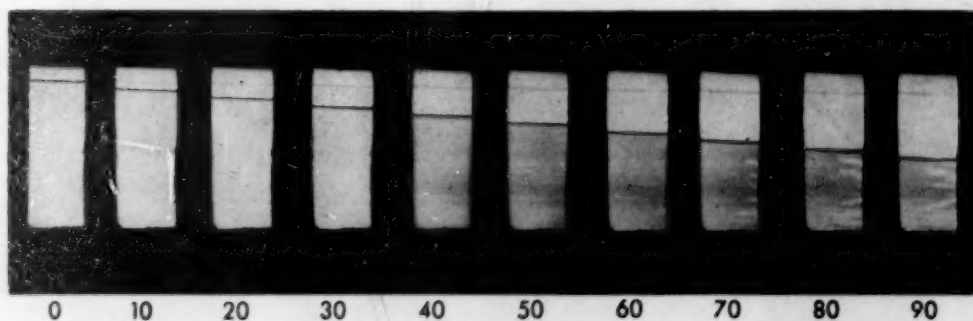
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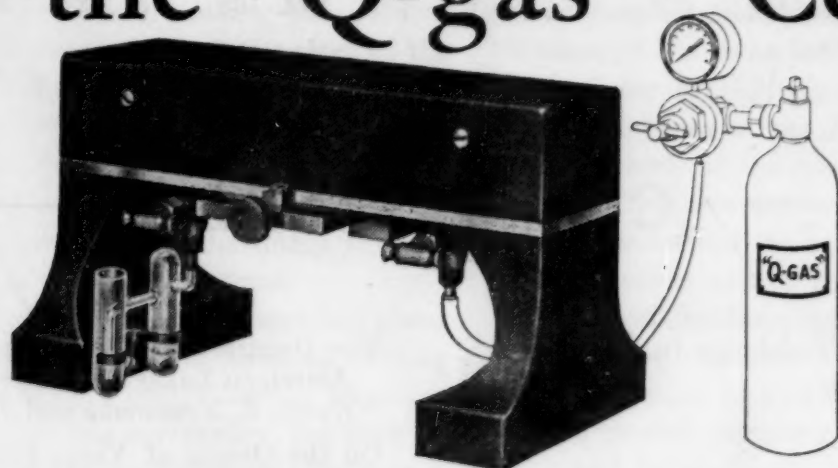


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Natural Resources Problems in Japan

Lieutenant Colonel Hubert G. Schenck, *Chief,*
Natural Resources Section, General Headquarters,
Supreme Commander for the Allied Powers, Tokyo, Japan

IF THE TRAGEDY OF A WAR only compounds the tragedies of its causes, nothing can obscure its waste. If hostilities cannot settle most of the issues which brought these hostilities into being, and if the greater portion of the conflicts and frustrations which bred the initial violence remain unaffected or even aggravated after the war has come to an end, then the terms of the victory are inevitably revoked and the peace becomes a temporary truce.

In Japan, the outcome of the Pacific war has given the Allied Powers the opportunity to direct all of their wisdom and good will toward mitigating the tragedies of its causes. Seen from this perspective, the work of the occupational forces has an historical significance of the first magnitude. What is being done in Japan to build a good society, economically, socially, and politically, may, if it is successful, serve to justify the efforts and sacrifices of millions of people in fighting this part of World War II.

Japan's complex economy is closely geared to her natural resources, and some of the most intricate problems of the occupation have involved the technology of their use. Her oligarchic social structure derived much of its strength from hereditary ownership, concentrated in relatively few hands, of the natural wealth of the land and the sea, and sweeping reforms in the rights to these resources have had to be made. Work in this direction began early in September 1945, only three weeks after General of the Army Douglas MacArthur was designated Supreme Commander for the Allied Powers. On October 2, 1945, the Natural Resources Section was established as a special staff section of General Headquarters to advise and inform him on policies and activities pertaining to agriculture, fisheries, forestry, and mining (including geology and hydrology) in Japan.

The scientists at work on this project have been drawn from the ranks of the Army, the Navy, and other governmental agencies, from academic and research institutions, and from private industry. Their duties include arranging for and coordinating surveys and reports in the pertinent fields; locating and arranging to obtain source data in Japan relative to pertinent activities in countries formerly occupied by

Japan; recommending measures to insure the development, exploitation, production, processing, and distribution of the basic industry products to the extent required for rehabilitation of the national economy within the terms of the Potsdam Declaration and to meet the needs of the occupation forces; and making recommendations relative to the conservation of natural resources and the operation or nonoperation of basic industries and of related scientific activities.

Because of the disintegration of the Japanese economy resulting from the war, it was first necessary to make immediate provision for a subsistence level of food, to provide minimum quantities of fuel and minerals, and to accelerate production of building materials. Thus, short-range problems of increasing food production by adequate production and distribution of fertilizer, by reclamation of unused arable land, for agricultural purposes and by supervision of crop collections were the first agricultural problems. The urgent needs of the fisheries were primarily vessels, nets, cordage, and fuel. So far as the forests and the mineral resources were concerned, the primary problem was to increase fuel production and to obtain as much lumber for rebuilding as was consistent with future productivity of the forests. Maximizing indigenous production of Nippon's natural resources remains the project of highest priority.

Some of the resources are renewable if properly managed. Accordingly, the sequels to these immediate problems were the problems of sustained yields. Consideration has been given to agricultural research and dissemination of its results, to research on fish population management, to reforestation and erosion control, and to improvements in technology of use of wood products. Finally, the Japanese have been encouraged to begin planning on a national scale for the development and use of their natural resources.

While the problems dealing with mineral resources are not identical with those of the renewable resources, they follow similar patterns. It has been necessary to eliminate obstacles to production and to attack the problems of developing mineral reserves and reducing waste in their exploitation. In all of these fields, a large part of the over-all problem is the determination of the actual state of the economy—that is, the obtaining of reliable statistics.

In this nation of so many people on so little land,

This article was prepared for presentation at the 18th Session of the International Geological Congress, London, England.

food production is the most pressing single problem. Current yields from the 15,000,000 acres under cultivation are not sufficient to feed the population of nearly 80,000,000 and in all likelihood never will be. Although Japan may succeed, by increasing both yields and acreages, in producing a bare subsistence requirement, we see no escape from the conclusion that food will always have to be imported, particularly in the light of the net increase in population of more than 1,000,000 per year. Any increase in the domestic food production is of interest, both to the American taxpayers, who paid more than \$295,000,000 in 1947 for food for Japan, and to the citizens of all of those countries who, during these last few years, have had to look beyond their own boundaries for food. The low fertility of Japanese soils, the shortage of fertilizers, the scarcity of unused arable land, and plant diseases are major obstacles to increased food production.

Before World War II, Japan was one of the world's largest consumers of commercial fertilizers both in amount per unit area and in total tonnage, and practically all the phosphate and potash fertilizer used was imported. The addition of reclaimed land to the total cultivated area and the steady growth of population make present and future fertilizer requirements greater than those of prewar years. In order to supplement the inadequate supply of domestic fertilizer, high priority has been given to the importation of ammonium nitrate, phosphate rock, and potassium salts. Since the end of hostilities, more than 1,500,000 metric tons of all types of fertilizer have been imported. Priority has also been given to the rehabilitation of factories for the manufacture of nitrogen fertilizer and for the conversion of phosphate rock and potassium salts to fertilizer. Japanese workers, under the supervision of General Headquarters personnel, are mining phosphate rock in Angaur Island in the Palau group. These operations have contributed substantially to raise 1947 agricultural production to 93% of the 1931-40 level, whereas 1945 production was only 76% of that level.

Although the Japanese have long recognized land reclamation as an important means of expanding cultivated acreage, past reclamation programs have been ill conceived and managed. At the beginning of the occupation, American agricultural specialists reviewed the reclamation program of the Japanese Government and recommended revisions of certain plans and practices. Surveys of 370 areas proposed for reclamation are now in progress under the direction of these men. Reclamation projects have already added about 770,000 acres of arable land to the cultivated acreage; improvement projects have added 250,000 acres more. In addition to the land reclaim-

able for agriculture, Japan has about 3,000,000 acres of uncultivated, nonforested slopes which are being investigated as possible pasture and forage lands for livestock.

National land-use programs and better planning for future production are urgently needed in Japan to insure maximum agricultural and forest returns. In order to provide a sound basis for these plans, American scientists have carried nearly to completion a reconnaissance soil survey. This survey, the first to employ modern methods of classifying and mapping Japanese soils, allows comparisons between soil groups in Japan, as well as with soils of other parts of the world. It provides for the first time a general inventory of soil types for the use of those agencies responsible for increased food production through land reclamation and improvement.

American experts have worked with Japanese officials on problems of insect and plant-disease control. Japanese spray equipment is antiquated, and dusting has had only limited use. Because of the poor equipment, as well as the scarcity of oil for the preparation of emulsions, the use of insecticide and fungicide dusts is now being encouraged. New insecticides have been introduced. Japan is currently producing about 150 tons of DDT annually, and the manufacture of benzene hexachloride has been started. In an effort to control virus and other diseases, an intensive program has been initiated for producing certified white potato seed.

There are 666 national and prefectural agricultural experiment stations, seed increase farms, livestock breeding farms, and sericultural service stations in Japan. In addition, 273 private laboratories and educational institutions are conducting research in agriculture. Research in some fields was found to be highly developed and skillfully conducted. Some of the most notable work has been done in sericulture and small grain variety improvement and in cytogenetics. Unfortunately, much of the agricultural research in other fields has been of little scientific or practical value. A lack of central guidance and coordination has resulted in extensive duplication of effort on some problems and neglect of other equally important phases of agriculture. Thus, economic aspects of agricultural production have received almost no attention from the research standpoint. Modern design of experiments and statistical analysis of data are almost unknown. However, in spite of its weaknesses, agricultural research in Japan has been responsible for making Nippon the outstanding country in the Far East in agricultural production.

Agricultural extension work, as a means of disseminating the results of research, has been conducted by quasigovernmental agricultural associations. Al-

though this system has been effective in forcing farmers to adopt some improved farm practices, more than 40,000 public employees have been required to carry out the program. After considerable study of Japanese agricultural research and extension, American specialists recommended that the Japanese Government develop a closely coordinated research and extension system. As a result of these efforts, the Japanese Diet on July 5, 1948, passed two laws which provide a legal basis for reorganization of these lines of work. The first establishes in the Ministry of Agriculture and Forestry an Agricultural Improvement Bureau which is responsible for the coordination and technical guidance of research and extension activities. The second provides the basis for the national government to conduct research and extension work cooperatively with the prefectures.

A corollary to the production problem is the administrative task of establishing staple food collection quotas to insure equitable distribution of crops in the existing inflationary economy. Accurate appraisals of the food situation had been hampered by the Japanese Government's inadequate crop-reporting system which depended on reports by local officials, responsible primarily to local agencies. To rectify this situation, the Ministry of Agriculture and Forestry was assisted in establishing an autonomous Statistics Bureau, which controls branch offices at prefectural and village levels. Marked effectiveness of the new system will not be attained for several years because of lack of trained personnel, but great improvement over the old system is expected.

Although provision of a minimum caloric subsistence level for Japan is primarily an agricultural responsibility, the principal sources of animal proteins in the Japanese diet are fish and other marine products. American fisheries technologists have supervised a program to make the best possible use of critically scarce equipment and to increase imports of needed raw materials. Under this program, fishing boats have been built, fuel oil, cotton, abacá, and other fibers have been imported, net and twine factories and cold storage and refrigeration plants have been restored to use. Production has been increased from the 1945 level of 4,000,000-5,000,000 pounds to more than 7,000,000 pounds, which is about as much as the present fishing area can support.

Gen. MacArthur has authorized the Japanese to conduct Antarctic whaling expeditions during the past two years. These have been accompanied and supervised by his personal representatives, and all operations have been in accordance with the International Whaling Convention. Utilization of catches during the last expedition was well-nigh total. The yield from these operations has supplemented the Japanese

diet where it is most deficient, namely, in animal protein and fat, and has included valuable by-products. A third expedition, operating under similar conditions, will leave for the Antarctic this November.

The productivity of the Japanese fisheries is due to more than the coordination of Western technology with the Japanese economy. Japan itself has done more research on technological and biological problems in fishing methods and development of new fisheries than has any other nation. Now, however, exploitation has reached the point where some marine populations are being badly depleted. Unfortunately, also, corrective measures are not available, because little attention has been paid to the long-range and more complex problems of fish-population management. For a stable economy it will be necessary in the future to devote the major research effort to good management rather than to exploitation of these resources. American scientists are emphasizing to Japanese scientists, government officials, and industrial representatives the necessity of directing their research along those lines in the interests of sustained yields.

In pursuit of these objectives, a committee of competent Japanese scientists and fishing industry representatives has been appointed by the Minister of Agriculture and Forestry to plan a reorganization of the aquatic research of both government and university facilities. The committee will also study the planning and financing of long-term programs and the efficient use of facilities. They have recommended the reorganization and elevation in status of the Bureau of Fisheries. Pursuant to this and supporting recommendations, the Diet on July 1, 1948, reorganized the Bureau and gave it the higher status of a Fisheries Agency, with broad powers to conduct the planned research projects, direct the practical application of the results, and supply information to Japanese fishermen through extension programs.

The concentration of wildlife in Japan is, to anyone familiar with conditions in the United States, appallingly low. The diminution of wildlife up to now has been related closely to the increase in the population and the pressure for food. Legislative action has been taken to prevent extinction of insectivorous birds and to halt the wholesale destruction of game in order to insure sustained yields. There is need for a well-conceived wildlife conservation program, but a great deal of effort will be required by Allied experts to initiate and execute such a program. The most obvious material benefits would not be inconsiderable, for even as recently as the years from 1931 to 1941 the annual harvest of wild meat averaged 7,000 tons.

Japan's forests, which suffered from overcutting and insufficient replanting during the war, are now

subject to heavy demands for reconstruction. The major task of Gen. MacArthur's staff in this field is to institute measures to counteract the wartime over-exploitation and at the same time to furnish necessary wood for fuel and construction. Surveys show that Japan faces the possibility that its more desirable timber stands will be exhausted within 15 years. Less than 25% of the present forest area furnishes 85% of the annual timber production. The Government has a 5-year reforestation program which aims to place timber production on a sustained-yield basis. American foresters supervised the planning and administration of this program, through which 780,000 acres have been reforested since the beginning of the occupation. They have the continuing objective of seeing that it is maintained rather than being postponed and diminished, as were earlier reforestation programs.

Although all accessible forest areas have been over-cut, approximately one-tenth of the total forest lands of Japan, or one-fifth of the wood volume, has been unexploited because of lack of roads. Some of these inaccessible areas are in Hokkaido; most of them are near large consuming centers on Honshu. Roads constructed since the beginning of the occupation have made 495,000 acres of forest land accessible. Although this project is progressing satisfactorily, material shortages and increasing labor costs are impeding progress.

Erosion control is closely related to reforestation. Japan's rugged topography, heavy precipitation, long shoreline, and strong coastal winds contribute to serious erosion and to sand dune movement. The denuding of mountain slopes for many years has aggravated these problems. The removal of natural water controls has resulted in silting of river channels, which, in turn, has retarded the normal run-off of excess waters and increased the threat of floods in some of Japan's most productive farmlands. Gen. MacArthur is stressing the replanting and management of the protection forests which have been damaged by excessive and unauthorized cutting.

Material savings have been effected by introducing improved methods of processing pulpwood. One of these, a semichemical pulping process adapted to present pulp mill equipment, yields one-third more pulp than the former process and gives consistently better quality papers. Another improvement was the addition of locally procured volcanic ash to red pine pulp in order to overcome pine pitch difficulties in the manufacture of newsprint. Information on improved processes in manufacturing machine-coated and kraft papers has been given to the industry and is being used by paper mills. General specifications for various types of paper have been developed and used for

the first time in the Japanese paper industry. In the plywood industry, similarly, specifications have been adopted, and improvements in gluing techniques have also been effected. New processes for the utilization of forest and pulp mill wastes have been introduced.

Emphasis in forestry research has been to establish coordinated programs designed to utilize wood more efficiently and to increase the productivity of the forests. The 13 central government experiment stations now have a single director, and much former duplication of studies has been eliminated. The work of the other 34 experiment stations is being reviewed. Although industrial research is behind that of other industrial nations, progress has been made not only on wood waste and sulfite liquor saccharification for yeast fodder and alcohol production, but also on lignin utilization, wood fuel, and wood preservation.

Let us turn now to mineral resources. The coal mining industry was in a particularly bad condition when World War II hostilities ceased. The demands of the war industries had forced a huge increase in coal production, with little concurrent exploration, development, or maintenance. In late 1945 production had declined to only 600,000 metric tons per month; nonindustrial requirements alone were three times as much as this. Today, the minimum coal requirement is 36,000,000 tons annually, while production is about 31,500,000 tons.

Programs of geological exploration and studies of engineering and social problems designed to help the Japanese Government to increase the productive efficiency of the coal mines have been initiated. American engineers have completed studies of mining techniques, equipment requirements, and labor utilization throughout the industry. Depletion of developed reserves in the mines, war damage to surface installations, the accumulated effects of poor maintenance, and shortages of housing, materials, and equipment are the physical handicaps to increasing production. Economic difficulties include the effects of inflation, unsatisfactory labor relations, and monopolistic management.

Surveys of the principal coal- and lignite-producing fields were made, and data on proved and potential reserves were assembled. Through the efforts of General Headquarters personnel, a Coal Exploration Advisory Committee was formed to insure proper coordination and guidance of exploration activities by the Japanese Government agencies. This committee, which includes the best-qualified Japanese coal geologists, engineers, and technologists, might be compared with the Regional Committees which operated under the chairmanship of the Regional Controller of the Ministry of Fuel and Power in England and

which have recently carried out surveys of each coal region in Great Britain. Current emphasis in Japan is on the remapping and surveying of solid fuel deposits, on preliminary geological field studies, on seismic prospecting on a national scale, and on related research, aimed to extend present fields and establish new reserves.

The development of Japan's meager petroleum resources has been slow. For the purpose of coordinating exploration and executing a balanced program of geological and geophysical surveying and exploratory drilling, Gen. MacArthur sponsored the establishment of the Petroleum Exploration Advancement Committee, the members of which are drawn from the Japanese Government agencies, private producers, and the universities. Several small new oil fields and extensions to two producing fields have been discovered.

Although the reserves of coal are adequate to meet the requirements of industry, Japan has never been able to fill her requirements for metals from her own mines. Lack of foreign exchange, however, has made it imperative that maximum use be made of available mineral resources. As with the coal mines, overproduction from metal mines during hostilities, with the concurrent lack of development and wearing out of equipment, has left mines in poor condition to meet present demands. Gen. MacArthur's staff has conducted studies of the available metallic mineral resources. Both the geology of the deposits and mining and milling techniques were investigated. New blasting techniques introduced by American engineers have increased the speed of driving development workings. Efforts have been made to educate the Japanese in techniques of selective mining in the narrow veins, common to many of Japan's mineral deposits, to reduce the quantity of barren waste being hoisted and processed through mills already in a serious state of deterioration from overuse. Some improvement in mill recoveries has resulted from insistence upon more attention to better control of mill feed and reagents.

Pyrite, one of the few minerals of which Japan has adequate quantities to satisfy her needs, is the principal source of sulfur in her sulfuric acid industry. Close attention has been paid to maintaining production adequate to meet the sulfuric acid requirements of the fertilizer industry.

No less than in other phases of the mining industry, wasteful practices were found to be common in metallurgical plants. Merely by introducing new methods for the production of copper "starting sheets" for use as cathodes in electrolytic refining, man hours required in this operation have been reduced by more than 50%, and, in addition, it has been found that the

percentage of rejects, because of faulty finished sheets, has been reduced from 25% to about 2%. By introducing improved "poling" techniques in refining electrolytic copper, General Headquarters technicians were able to reduce plant fuel consumption as much as 27%. Similar improvements are being introduced as rapidly as the industry can assimilate the new techniques.

Research within the mining industry must be coordinated, and universities and mining companies must share their findings, if optimum utilization of Nippon's meager but varied mineral resources is to be obtained. There is striking need for an extensive reorganization of the Japanese Mining Bureau, the past complexion of which has been largely political. Current recommendations call for the creation of a Research Division, staffed by competent technologists and directed to provide for a greater exchange of information between public and private agencies. In addition, General Headquarters is advocating that the laboratory facilities of the large mining companies be made available to both academic researchers and smaller mining companies. And related to research is the newly established centralized statistical section of the Japanese Mining Bureau, an organization that provides for the first time in Japan an agency for coordinating the gathering of mineral statistics.

As a result of the study of all natural resources, it has become fairly clear that, while both Japanese science and Japanese technology are based on European and American foundations, the liaison between them has been poor. Again, economic planning has never been considered on a national scale. Indifference toward national economic planning is a luxury Japan can ill afford, but Japanese science and technology have never been in a position to attack the problem on a practical basis. These shortcomings are particularly regrettable in a country of such limited per-capita resources. Gen. MacArthur has stressed the need for a centralized agency to coordinate national planning programs in the interests of Nippon's natural resources. A first step was taken toward this goal by the creation of a Resources Committee, established by a Cabinet Order of November 13, 1947. This committee, which functions under the auspices of the Japanese Economic Stabilization Board, is composed of government and academic specialists in geography, mining, geology, metallurgy, forestry, agriculture, chemistry, and power engineering. Its first concern is to plan and coordinate government activities relating to land, water, and energy utilization.

At the same time that these technological changes were being instituted, the Supreme Commander took steps designed to lead the Japanese into a more democratic way of life. The social problems of present-

day Japan are intimately related to those of development of her resources. The land reform program, which has been correctly singled out by all commentators as Gen. MacArthur's most important reform, strikes at the roots of the feudalistic agrarian system which has held Nippon's tenant farmers in economic bondage for centuries. This reform provides for the purchase of 4,500,000 to 5,000,000 acres, or approximately 80% of the tenant-cultivated land. The tenants will become owners of that land. The program is being carried out smoothly and expeditiously. Most of the land subject to the reform has already been purchased by the Government, and 75% of it has already been resold to the tenants. The end of 1948 will witness the successful completion of the historic and far-reaching reform. The economic and social status of Japanese farmers has been further improved through the dissolution of autocratic and regimented agricultural associations through which the Government dominated the agricultural economy during the war. Agricultural cooperative legislation enacted by the Diet in November 1947 authorizes farmers to organize, on a voluntary basis, democratically controlled cooperative associations formed on internationally recognized principles.

In the fisheries, the long-continued pressure for food has resulted in the development of property rights in aquatic resources to a far greater extent than in any other country. While maintenance of a system of fishing rights is essential to retard depletion of this heavily burdened resource, the existing system is full of abuses, including excessive concentration of fishing rights, absentee ownership, exorbitant rentals, and a complexity almost beyond comprehension. Study of this problem has led to the preparation of two bills which, it is anticipated, the Diet will pass during the next session. The Fisheries Rights Bill will simplify the present classification of 6 groups and almost 3,000 subgroups of rights into 5 groups and 7 subgroups. Rights will be granted according to an eligibility and priority schedule established by law to reduce personal latitude by officials, committees elected by the fishermen from among themselves will arbitrate disputes, and actual operators alone will be entitled to fisheries rights. Provision is also made for a rational system to control intensity of fishing. The Fishing Cooperatives Bill will provide the machinery whereby fishermen can work together for their common interests.

Ownership of forest lands is divided roughly equally between the prefectures and national govern-

ment on the one hand and private individuals on the other. Individual holdings are for the most part too small for efficient forest management and are not a hindrance to social reform. Accordingly, since economic considerations in this case bulk larger than social considerations, the members of General Headquarters have opposed compulsory changes in ownership.

In the field of mining and geology, programs of decentralization of economic power are now being detailed. General Headquarters personnel are cooperating in the development of these projects with the objective of maintaining the greatest efficiency of use of the resources which is consistent with needed reform in management. A safety program for the coal-mining industry has also been proposed which includes safety education of the miners and regulations for mine operation at progressively higher levels over a period of years. It has the ultimate objective of attaining Western standards of safety.

The basic technical information obtained by members of Gen. MacArthur's headquarters in the course of the surveys of Japan's natural resources has been issued in a series of published reports which provide an analysis and a compilation of the most valuable statistical data on these subjects obtainable in Japan. They thus serve as points of departure for future investigations. Moreover, they are of practical value to Allied industry because for the first time they make available the information concerning Japanese natural resources and exploitation techniques. Such reports are an index of Japan's production potential and a prerequisite for determining policy toward postwar development of industry and foreign trade. Above all, these publications serve as a foundation for the evaluation of Japan's capacity for achieving economic self-sufficiency.

This account of the activities of the Natural Resources Section has highlighted certain problems of resources utilization and the work of Allied scientists in assisting Gen. MacArthur to develop a sound basis for the formulation of reconstruction policies. It would fail in its intent, however, if it did not make clear the fact that other staff sections of General Headquarters and the Military Government teams of the Eighth U. S. Army have made comparable contributions in their respective fields toward the solution of the basic problem of the Allied Powers—the development of a sound economy for a free, noncolonial, democratic Japan, for a Japan that will neither need nor want to wage war again.



NEWS and Notes

Edwin G. Williams, senior surgeon, U. S. Public Health Service, who has for several years been engaged in research and field studies of radiation protection, has been assigned to the Office of the Surgeon General, Sanitary Engineering Division, to establish a Section on Radiological Health.

John E. Cushing, formerly instructor in biology at Johns Hopkins University, has been appointed assistant professor of bacteriology at the University of California, Santa Barbara College. Dr. Cushing will continue his research on the genetics of adaptation in microorganisms.

C. P. Idyll, formerly associated with the International Pacific Solomon Fisheries Commission at New Westminster, British Columbia, has been appointed research associate at the Marine Laboratory, University of Miami, Florida.

Jacques Rousseau returned to the Montreal Botanical Garden at the end of August after performing a botanical survey of northern Quebec along the Kogaluk and Payne River, a sector which, for the greatest part, was being visited for the first time. He was accompanied by E. Aubert de la Rüe, geologist, Jean Michen, archeologist and ethnologist, and Pierre Gadbois, geographer.

Miguel Covarrubias, famous Mexican artist and author, will be Walker-Adams professor of anthropology at the University of Washington, Seattle, during the fall quarter.

David Nicol, formerly of the University of Houston (Texas), has been appointed associate curator of Invertebrate Paleontology and Paleobotany at the U. S. National Museum, Washington, D. C. Dr. Nicol will be in charge of Tertiary fossils.

Cecil J. Watson, professor of medicine, University of Minnesota Medical School, will deliver the first Harvey Lecture of the current series at the

New York Academy of Medicine on October 21. Dr. Watson will speak on "Urobilin and Stercobilin."

E. U. Condon, director of the National Bureau of Standards, left for Paris October 1. Dr. Condon will serve as chief of the U. S. delegation to the International Conference on Weights and Measures, which will be held October 12-21. **E. C. Crittenden**, associate director of the Bureau, who preceded Dr. Condon to Europe, will also attend the Conference.

Friedrich P. Ellinger, of Koenigsberg, Germany, has recently joined the permanent staff of the Navy's Research Institute at the Naval Medical Center, Bethesda, Maryland, as technical director of all research in the field of radiation biology. Dr. Ellinger, who became an American citizen in 1944, has been associated with the Long Island College of Medicine as director of its Laboratory for Experimental Radiation Therapy Research and with the U. S. Veterans' Hospital at the Bronx, New York, as a consultant.

Ralph W. G. Wyckoff, of the National Institutes of Health, Bethesda, Maryland, left recently for Europe. While there, Dr. Wyckoff, who is known for his research on the biophysical preparation and the electron microscopy of purified viruses, will receive an honorary doctor's degree from the Faculty of Medicine of Masaryk University, Brno, Czechoslovakia. This is the first such degree bestowed by the University since the end of the war.

Walter H. Voskuil has been appointed professor of mineral economics at the University of Illinois. Dr. Voskuil will also continue his work with the State Geological Survey.

C. Donnell Turner, formerly of the Department of Zoology, Northwestern University, has been appointed associate professor of biology at Utica College of Syracuse University.

Toivo M. Liimatainen has been appointed to the staff of the National Bureau of Standards, where he will work on the engineering and development of microwave tubes. Mr. Liimatainen has done extensive work on the

design and development of microwave oscillator tubes and gas discharge tubes, as well as on the design and application of high back-voltage selenium rectifiers.

Awards

Leo C. Massopust, of the Marquette University School of Medicine, was named first Annual Award winner by the Board of Directors of the Biological Photographic Association at the Association's recent convention in Philadelphia. He received the award, as anatomical artist, medical photographer, and radiographer, for his extensive contributions to the aims, activities, and ideals of biological photography and was also cited for his activities as editor of the Association's journal.

Marston T. Bogert, emeritus professor of organic chemistry, Columbia University, has been chosen as the first recipient of the recently established Medal of the Society of Cosmetic Chemists. The award is made "for outstanding professional contributions," and the presentation will take place at a special meeting of the Society in New York City on the evening of December 8.

Duncan A. MacInnes, of the Rockefeller Institute for Medical Research, has been awarded the Edward Goodrich Acheson Medal and Prize for outstanding contributions to the science of electrochemistry. Presentation of the medal and prize will be made at the convention dinner of the Electrochemical Society to be held at the Hotel Pennsylvania in New York City on October 14. Dr. MacInnes, who has been associated with the Rockefeller Institute since 1924, formerly served as president of the Electrochemical Society and held the Sigma Xi National Lectureship in 1940.

George Graves, of Boston and Martha's Vineyard, Massachusetts, has been named the 1948 winner of the James R. Jewett Award. This award is presented annually by the Arnold Arboretum of Harvard University to the individual making the most significant contribution to the improvement of the native beach plum. Mr.

Graves was recognized for his experiments in producing more consistent fruit set and later blooming varieties. The annual award was made possible by a grant of money given to the Arnold Arboretum by James R. Jewett, emeritus professor of Arabic at Harvard.

Fellowships

The National Research Council of Canada has awarded 31 medical fellowships varying in amount from \$1,500 to \$2,500 to graduates in medicine for postgraduate research during 1948-49. The grantees represent 10 different universities, including one in Australia and one in England. Fellowship holders will carry on their work at 8 universities, as follows: McGill, 8; Montreal, 1; Queen's, 4; Toronto, 7; Western Ontario, 8; Manitoba, 1; Oxford, England, 1; and Zurich, Switzerland, 1.

The Atomic Energy Commission has announced the award of 162 new research fellowships in the physical, biological, and agricultural sciences to applicants from 30 states who will study in 43 different institutions. The number of graduate students selected for training under the AEC-financed fellowship program during 1948-49 now totals 206. Under this program, which is designed "to insure continued expansion of research and development in atomic energy and related fields, to alleviate the shortage of trained scientists and technicians, and to assist in the acquisition of a growing fund of theoretical and practical knowledge," awards have been made both to researchers already holding the doctor's degree and to students working toward the degree.

The National Research Council, which is administering the program, will continue to accept applications, and additional awards will be made this fall and next spring.

Two fellowships for training in enzyme chemistry have been made available by the Williams-Waterman Fund of the Research Corporation to the Institute for Enzyme Research of the University of Wisconsin. One of the fellowships is intended for recent graduates with a Ph.D. degree; the

other, for a more senior investigator. The stipends will range from \$3,000 to \$4,000. Applications should be sent to Dr. D. E. Green, of the Institute for Enzyme Research.

Colleges and Universities

"Frontiers in Chemistry" will again be the subject of a symposium lecture series this autumn at Wayne University. Eight consecutive Monday evenings will be devoted to the series, with outstanding chemical scientists from midwestern and eastern universities appearing as lecturers and discussion leaders for each program.

The participants will go to Detroit under the joint auspices of Wayne's Department of Chemistry and the International Society of the Friends of the Kresge-Hooker Library.

Roger Adams, head of the Chemistry Department at the University of Illinois, will speak at the initial program, Monday, October 11. This program, like others in the series, is scheduled for 7:00 P.M.

Subsequent lecturers and their subjects will be: October 18—W. H. Zachariasen, Department of Physics, University of Chicago, "Crystal Chemistry of the 5F Series of Elements"; October 25—F. H. Westheimer, Department of Chemistry, University of Chicago, "A Quantitative Theory of Steric Effects"; November 1—William S. Johnson, Department of Chemistry, University of Wisconsin, topic to be announced; November 8—John C. Bailar, Department of Chemistry, University of Illinois, "Stereochemistry of the Metal Amines"; November 15—Christopher Wilson, University of London and Ohio State University, "The Mechanism of Reduction"; November 22—James J. Lingane, Department of Chemistry, Harvard University, "New Developments in Electro-Analytical Chemistry"; and November 29—Lynne L. Merritt, Department of Chemistry, Indiana University, "Chelate Complexes in Analytical Chemistry."

A nominal registration fee of \$5.00 for the entire series is being charged. Requests for registration cards should be addressed to Prof. Neil E. Gordon, coordinator of the series, and accompanying checks should be made payable to Wayne University. Ar-

rangements may be made by qualified persons to earn graduate credit if they so desire.

Installation of a 25-Mev betatron has just been completed in the Department of Physics at the University of Saskatchewan, Saskatoon, Canada. Funds for the betatron, one of the first to be built commercially and delivered to a university laboratory, were supplied by the Canadian Atomic Energy Control Board, the National Research Council, the Cancer Institute and the Province of Saskatchewan. Less than a year after the order was placed with Allis-Chalmers of Milwaukee, and the ground broken for the building (especially designed for the purpose and erected by the Provincial Government), the installation was completed. The experimental work already begun, will be conducted mainly under the direction of four members of the Department of Physics: E. L. Harrington, department head, R. N. H. Haslam, H. E. Johns, and L. Kato.

The University of Illinois College of Veterinary Medicine has recently enrolled its first group of students for the 4-year professional veterinary course leading to the degree of doctor of veterinary medicine. Each of the 24 students accepted in the College has completed two years of preveterinary training. The B.S. degree may be conferred upon the students at the end of their second year of veterinary training. Upon the completion of two proposed new buildings, larger veterinary classes will be accepted. These new buildings will consist of a basic science building and an additional structure to house the activities of the Department of Veterinary Clinical Medicine and the diagnostic service of the College.

The University of Massachusetts has announced the following staff additions: David W. Bishop, formerly associate professor, University of Illinois, as professor of physiology; James G. Snedecor, formerly of Louisiana State University, as assistant professor of physiology; H. Duncan Rolleston, formerly an instructor at Amherst College, as assistant professor of zoology; and M. S. Cornell and Herbert J. Berman as new zoology instructors.

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A program of research and project engineering on land, at sea, and in air is under way, utilizing the facilities of the Allan Hancock Foundation for Scientific Research, the University of Southern California College of Aeronautics, and the new U.S.C. Marine Laboratory ship, *Velero IV*. According to Capt. Allan Hancock, who serves as director of the three groups, the new program will pursue laboratory, fundamental, and developmental research projects for governmental and industrial organizations on nonprofit basis. Maurice Nelles, of College of Aeronautics, has been named engineering and research manager with responsibility for technical and scientific management of the research projects.

The \$2,000,000 Laboratory of Nuclear Studies which was dedicated October 7 at Cornell University (see *Science*, October 1, p. 348 and this week's cover) consists of a main laboratory building and an adjacent structure housing a 300-Mev synchrotron, in which Cornell physicists hope to produce mesons. The main laboratory building contains 16 single and 3 double laboratories, four radiochemistry laboratories, two machine shops, an electronics shop, stockrooms, synchrotron control and detector rooms, and a roof deck for cosmic-ray research, exclusive of conference rooms and other facilities. As staff for the new Laboratory, which will be directed by Robert R. Wilson, there will be 18 faculty members, 24 other full-time staff members, 11 graduate research assistants, and 6 part-time or temporary technicians.

The present Laboratory facilities are an outgrowth of a broad program of both theoretical studies and experimental work begun in the 1930s by a handful of nuclear physicists, among whom were Hans A. Bethe, M. Stanley Livingston, Robert F. Bacher, and Lyman G. Parrat. These men, working with Lloyd P. Smith and other members of the staff, continued their research, and in 1946 the Laboratory of Nuclear Studies was officially established with Dr. Bacher as director. The latter was soon appointed member of the Atomic Energy Commission, and since that time Dr. Wilson, formerly of Harvard Univer-

sity and at one time head of the Division of Experimental Physics at Los Alamos, has been in direct charge of the final design of the buildings and their equipment.

Meetings and Elections

The Midwest General Meeting of the American Institute of Electrical Engineers will be held October 18-22 in Milwaukee, Wisconsin, with headquarters at the Schroeder Hotel. Thirty-four technical sessions and conferences in the broad fields of power, industry, communication, and basic sciences have been arranged. The conference sessions on industrial control, material handling, and automatic contouring have been scheduled so as to permit inspection trips to corresponding Milwaukee industries. E. W. Seeger is acting as chairman of the Midwest General Meeting Committee.

The postponed 16th Congress of the International Geographical Union is to be held in Lisbon, Portugal, April 8-15, 1949, with a series of excursions following the sessions. George B. Cressey, of Syracuse University, chairman of the National Committee of the United States, has recently returned from a meeting of the Executive Committee of the Union held in Brussels and reports that the German and Japanese Committees are to be recognized as soon as they reorganize. Italy is already an active member. The nongovernmental character of the Union was reaffirmed, and it was emphasized that the Lisbon Congress is open to all professional geographers, irrespective of political considerations.

The American Association of Blood Banks held its first annual meeting at the Hotel Statler, Buffalo, New York, August 26-28, immediately following the International Hematology Society meeting. According to Marjorie Saunders, Association secretary, approximately 200 persons attended the various sessions. There were also a number of foreign guests. The registrants, representing 28 states

and 6 foreign countries, indicated much interest in the program of scientific and administrative papers.

At the business meeting Ralph G. Stillman, of the New York Hospital Blood Bank, was elected president; Thomas H. Seldon, of the Mayo Clinic Blood Bank, president-elect; Ernest Witebsky, Buffalo General Hospital Blood Bank, vice-president; W. Quinn Jordan, Salt River Valley Blood Bank, Phoenix, Arizona, treasurer; and Miss Saunders, who is located at the William Buchanan Blood Center, Baylor University Hospital, Dallas, Texas, secretary. Directors for the 8 districts were also named.

Information regarding proceedings of the meeting and membership in the Association may be obtained from the office of the secretary.

The Division of Fluid Dynamics, established by the Council of the American Physical Society in June 1947, has been organized. By-laws have been formulated and approved by the Council. Under these by-laws an election was held in which the following were elected members of the Executive Committee: Jesse W. Beams, Howard W. Emmons, Theodor von Karman, for a one-year term; Hugh L. Dryden and Paul S. Epstein, for a two-year term; Raymond J. Seeger and John G. Kirkwood for a three-year term. A ballot by the Executive Committee has completed the organization by the election of R. J. Seeger, chairman, H. L. Dryden, vice-chairman, and H. W. Emmons, secretary-treasurer. Thus, the work of the original Fluid Dynamics Committee, consisting of H. L. Dryden, H. W. Emmons, J. G. Kirkwood, C. B. Millikan, R. J. Seeger, T. von Karman, and J. von Neumann, which has functioned for several years, will be continued in the future by the new Division.

H. W. Emmons has reported as follows with respect to the Division's meeting this past summer:

During the latter part of June a three-day symposium on heat transfer and fluid mechanics was held in the Los Angeles area under the auspices of the University of California at Los Angeles, the University of Southern California, and the California Institute of Technology. The meetings on Wednesday, June 23, were held

under the joint sponsorship of the symposium and of the Fluid Dynamics Division. This joint meeting proved to be highly successful in view of the caliber of the papers presented and the presence of a large number of workers in the field from all parts of the United States. The meeting was opened by a paper from T. von Karman on "Progress in the Statistical Theory of Turbulence," which presented developments and extension by the author of the isotropic turbulence theories of Kolmogoroff, Heisenberg, and others, and included certain specific predictions which have been satisfactorily checked by recent experiments. The second paper, "Viscous Effects in Compressible Flow," by Dr. Lagerstrom of CalTech, and two of his graduate students, gave preliminary results obtained during an investigation sponsored by the ONR. A theoretical study has been made of certain simplified flows in which both compressibility and viscosity effects are important. Somewhat idealized cases have been set up which permit both linear and nonlinear treatments of the problem.

The following very interesting experimental papers on interferometry were presented: "Some Heat Transfer Studies With the Zehndermach Interferometer," by Ernst R. G. Eckert, and "Interferometer Studies of Supersonic Boundary Layers," by Rudolf W. Ladenburg. The techniques described by these two authors have already produced important results, and it is quite apparent that they will be of great importance in the future study of compressibility flows.

In the first afternoon session the following three papers were given: "A Simplified Theory of Porous Wall Cooling for Turbulent Flow," by W. Duncan Rannie; "Experimental Study of Cooling by Injection of a Fluid Through a Porous Material," by H. L. Wheeler and Pol Duwez; and "Studies of the Gas Phase Transpiration Cooling Process Using Air as a Coolant," by Joseph Friedman. The new technique of transpiration cooling, which has been made possible by recent developments in powder metallurgy, appears to have great importance in connection with the cooling of rocket motors and of other containers subjected to extremely high

temperatures. The three papers indicated that very considerable progress has already been attained and that still more may be expected as the field is further investigated. The following two theoretical papers dealing with heat transfer problems also proved to be of great interest: "Heat Transfer in a Laminar Boundary Layer on a Porous Flat Plate With Fluid Injection," by S. W. Yuan, and "Stability of the Laminar Boundary Layer With Injection of Cool Gas at the Wall," by Lester Lees. The session was closed with a paper by Lindquist on "The Theory of Flow of Pseudo-Plastic Systems."

Deaths

Horace J. Macintire, 68, professor of mechanical engineering at the University of Illinois, died July 15 in Urbana.

Clarence C. Vernon, 52, head of the Chemistry Department, University of Louisville, died suddenly September 20 in Louisville, Kentucky.

Wallace A. Wilson, 63, Philip Schuyler Beebe professor of mathematics at Yale University, died September 21 at his New Haven, Connecticut, home.

Louis Cohen, 71, consulting engineer, author, and professor of electrical engineering, died in Washington, D. C., on September 28. Internationally known as a pioneer in the field of radio, Dr. Cohen had variously served with the National Bureau of Standards, as faculty member of George Washington University, and as consulting engineer for the War Department.

"Teaching Elementary Science," a new bulletin, has recently been issued by the Office of Education, FSA. Prepared by Blenn O. Blough, specialist in elementary science, and his assistant, Paul E. Blackwood, the booklet outlines the place of science in children's lives and in the elementary school program, along with practical methods of science teaching. Copies (Bulletin 1948, No. 4) are available at \$0.15 each from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

An experimental atomic power plant for studies of the generation of electric power from nuclear energy is to be located on 4,500 acres of land to be acquired by the Atomic Energy Commission in Saratoga County, New York. The plant will be part of the facilities of the Knolls Atomic Power Laboratory, which is operated by AEC by the General Electric Company at Schenectady. The nuclear reactor heart of an atomic power plant, which differ appreciably from the production reactors used at the Commission's Hanford Works. The new Knolls reactor is one of two being designed especially for studying high-temperature operation and the production of power. Choice of the location depended on its proximity to the plant and laboratory of the General Electric Company, the availability of water and power, the suitability of underlying formations for installation of heavy concrete structures, and the utilization of land of less agricultural productivity than that of other sites considered, while the size of the tract was determined by safety and security requirements and the displacement of as few people as possible.

Make Plans for—

6th Annual Pittsburgh Conference on X-Ray and Electron Diffraction, November 19-20, Carnegie Institute of Technology.

Optical Society of America, 33rd annual meeting, October 21-23, Hotel Fort Shelby, Detroit, Michigan.

Symposium on Ultrasonics and Macromolecules, October 3, Polytechnic Institute of Brooklyn.

American Mathematical Society, October 30, New York City.

American Society for the Study of Arteriosclerosis, annual scientific meeting, October 31-November 1, Hotel Knickerbocker, Chicago, Illinois.

American Institute of Chemical Engineers, annual meeting, November 7-10, Hotel Pennsylvania, New York City.

Geological Society of America, Mineralogical Society of America, Paleontological Society, and Society of Vertebrate Paleontology, November 11-13, New York City.

Comments and Communications

Immunologic

"Immunology" refers to a study of immunity or resistance to infection. The word "immunity" implies nothing with regard to any specific mechanism whereby it operates.

Immunity is a concept, implying that various constitutional factors may lead to an unusual resistance to infection. The one thing implied about the nature of these factors is that they are constitutional. The absence of mosquitoes or the death of bacteria may lead to what appears to be immunity, but it is not. Some factors which lead to a greater than normal resistance must reside in the exposed person.

Another word commonly used in bacteriology is "serology." This refers basically to the study of any reactions in which the serum of the blood is a component, but it is proper and helpful to restrict it to the study of reactions between proteins, called antigens, and certain globulins, called antibodies, found in the serum of the blood of animals inoculated with these proteins. Serology deals with specific observable reactions; in this sense it is observational rather than conceptual. The word "serology" implies nothing as to biologic connotations.

Let us now turn to a chapter on "immunology" in any textbook. In the first paragraphs we get an idea of the concept that resistance to infection varies; hence, there may be, relatively, the extremes, susceptibility and immunity. The gradient is given a fictitious solidity by bounding it with rigid definitions incompatible with so broad a concept, but it is there. There is an apologetic note; philosophic ideas are unworthy of mention in serious science because they cannot be weighed.

The chapter then shifts, frankly or subtly, to a discussion of what it calls the mechanism of immunity. This is introduced by a discussion of antigens and antibodies in which we learn that complex proteins, or antigens, when injected into animals, stimulate the formation of antibodies. When properly mixed, antigens and antibodies produce some demonstrable reactions.

In connecting the concept of immunity and the facts of serology, the text encounters semantic difficulties. It talks about "defensive mechanisms" and "protective" antibodies. Animals are "immunized." Cautious writers let readers catch themselves in these traps; less cautious writers say flatly that the mechanism of immunity depends on antibodies. Readers are told or led to believe that serology is a study of the mechanism of immunity. If asked, most authors would admit readily that cellular, mechanical, chemical, and other factors contribute to immunity. The reader of the text cannot ask them and does not get this impression.

Here is our argument. The concept of immunity does not imply any specific mechanisms. They are unquestion-

ably complex. They need not be alike in two different diseases. Serology, a study of observed reactions between antigens and antibodies, implies nothing intrinsically connected with immunity.

Possible relationships between immunity and serologic reactions constitute a *third* step in argument. Both the thoughts and the science behind immunology and behind serology are initially distinct. If we postulate as a third step that immunity is only an expression or a consequence of serologic reactions, we find more exceptions than agreements, but that need not concern us here. The point is only that the concept of immunity and the observations of serology should always be considered separately. Any move to bring them together should be deliberate and specific for specific situations. The causal connection is not general. Experts properly may argue about the relationships in any specific case. They cannot properly argue about either the immunologic concept or the serologic facts. Both the solidity of argument and clarity of understanding are improved by definite separation of these two ideas. Separation can be accepted equally by ardent believers in serologic explanations of immunity and by those who have other theories for explanation.

Once the divorce is effected, the semantics offers no trouble. We may *inoculate* an animal rather than "immunize" it. To newcomers, the thought of "immunizing" a rabbit is puzzling. How can you "immunize" a rabbit by inoculating it with a harmless substance, say the white of an egg or the dead bacilli of typhoid fever, to which in the living form the animal is resistant? When we collect serum from the blood of this rabbit, surely we may better call it an *antiserum* than an "immune serum." Andrews, in his recent *History of scientific English*, objects to "immunopolysaccharide" because it comes, a bit pompously, from three languages. We add oil to his good fire. The word is serologic; it refers to a form of antigen. Whether or not it has to do with immunity is open to debate with each substance to which these 8 syllables may be applied. Often, at least, there is no connection.

The phrase "immune serum" is startling to newcomers. How can a serum be immune or susceptible? Even if the serum could produce an immunity, usually not to the point, the serum is not immune. The phrase refers only to sera which contain antibodies. No immunologic thought is even possible with most of these sera. The word *antiserum* covers every thought involved without complicating the semantics; it does not imply too much, it inhibits no one's thoughts, it adds no new word or new connotation.

The semantic confusion of immunologic and serologic ideas distorts the thinking of students and their teachers and inhibits the development of our knowledge. Simple serologic explanations of immunity have caught the fancy of bacteriologists who should know better and consequently are accepted by those who depend on bacteriologists for their bacteriology. For 50 years, whenever the cause of a disease has been discovered, an immunizing vaccine and a therapeutic serum are immediately prophe-

sied because, by serologic theory, immunity is simple. The idea has an anthropocentric or teleologic appeal. It satisfies our curiosities. We like to think that everything is designed for our own good. Investigators work on serologic problems, report serologic observations, and then draw immunologic conclusions. Serology is laboratory stuff, but immunology is Big Time. Experts, on whom we must rely for authoritative information, have an obligation. Bacteriologists have rested their conclusions on a misleading argument for so long that they fool even themselves and each other.

The simple thought that antigens and antibodies explain immunity leads to serious errors with vaccines and therapeutic antisera. The persistence of searches for good vaccines is a tribute to human optimism. The persistence of the sophistry that anything which stimulates the production of antibodies is a vaccine is remarkable, but it is no tribute. The introduction of an antigen into an animal necessarily, by definition, stimulates the production of antibodies. The literature is full of writers who, after introducing evident antigens, express surprise over the discovery of antibodies. To argue that a vaccine produces a resistance to infection because it has stimulated the production of antibodies confounds theory, speculation, and fact. It would be equally logical to account for the immunity by the sore arm produced and to vaccinate with a club. Thousands of purported vaccines have failed immunologically; all stimulated the production of antibodies. No vaccine could fail if we accept the fallacious confusion of immunology and serology. Vaccines do fail, often, immunologically.

Although the serum of any animal which has been inoculated with antigen must contain antibodies, the antiserum may have no immunologic value. There is often no possible relation to immunity. Are we to suppose that the inoculation of a person with the organisms which cause fire blight of pear trees would be an immunizing process? There would be antibodies.

Here is a specific example. Typhoid vaccine, one of the few successful vaccines, confers a significant resistance. Those who are vaccinated rarely have typhoid fever after ordinary exposure. This is demonstrated by the rates of infection in vaccinated and in unvaccinated persons in regions in which the disease is common. An attack of typhoid fever also confers an adequate immunity in those who recover. There is exposure to the antigenic components of the bacillus of typhoid fever with either infection or vaccination. Therefore, antibodies are formed. Should we yield to the temptation to argue that the immunity is *caused* by the antibodies? The factual observation is *only* that in this case antibodies and immunity usually coincide. But apparently serum of high antibody content is not of immunizing value, and quite surely persons with very little antibody after vaccination are as immune as those with much. We may also argue that in any infection permitting absorption of antigen there are antibodies, but in only a few do we have immunity or vaccines. That immunity and antibodies coincide proves nothing about causal relationship. Other explanations of the immunity have a stronger claim.

We are reporting an experiment. These ideas have been tried consistently on many academic and professional students. It is no trouble to lecture without mixing serology and immunology. It antagonizes no one and it disturbs no one's right to decide when he wishes to relate immunity and serology. None of us working with our classes uses the inappropriate terms, such as "immunizing" a rabbit; each catches these phrases when others use them. There is no dogma in this. The dogma is in the enforced relationship between immunity and serology, not in the freedom which we should like to promote.

The origin of the confusion does not excuse it. The reactions between toxins, which are also antigens, and their antibodies happen to result in the neutralization of the poisonous properties of the toxins. This early observation, antedating other serologic observations, combines an immunologic concept and a serologic observation. Serologic principles arose from this observation and phenomena observed later. Introduce the white of an egg into a rabbit and there is stimulated the formation of antibodies which will precipitate the white of an egg. There is no immunologic thought whatever in this. Serology has expanded to a useful and moderately exact branch of science. It is incumbent upon us to keep it separate from immunity except when the connection is clear and irrefutable. Only after immunologic thoughts and serologic facts are each separately understood can possible relationships be examined. *First*, there is the immunologic concept concerned. *Second*, there are the observed serologic phenomena. *Third*, there may be considered combinations. Occasionally, and not often, immunologic phenomena appear to have serologic mechanisms.

We plead for separation of the concept of immunity and the phenomena of serology. Separation leads to a more precise expression of facts and arguments and to fewer fallacious deductions from our observations. Separation can be done with language, but so deeply is the error planted that bacteriologists can get out of it only by prolonged effort. We owe this effort to students and to others who wish to grasp something of scientific thought. We owe it to science, built upon reliance in the observations and logic of specialists in each component of science.

M. S. MARSHALL

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A Comparison of the Total Leucocyte Count in the Heart Blood and Peripheral Blood of the Rat

In a recent issue of *Science* (April 30, p. 447) Quimby, Saxon, and Goff reported that the leucocyte count of the heart blood in the rat is only about one-fourth that of the peripheral blood (heart blood = 6,425 leucocytes/mm³; tail blood = 23,810). In view of the large number of experiments which have been based on leucocyte counts of tail blood, this report seemed worth checking.

Twenty-seven male albino rats (Wistar strain) weighing 200 gm each and 8 male rats of mixed strains weighing 200-400 gm each were used. The Wistar rats were lightly anesthetized with ether and 0.25 ml of blood obtained by cardiac puncture, using a 27-gage needle. Immediately afterward, peripheral blood was obtained by picking one of the dorsal tail veins with a sharp razor blade and collecting the free-flowing blood.

47-49) have demonstrated that restraint induces a lymphocytopenia in mice. The animals were kept at all times in an air-conditioned room at a temperature of $78 \pm 3^\circ \text{F}$.

Total leucocyte counts were made by standard methods, using Bureau of Standards certified equipment. Monocytes were not distinguished from lymphocytes, nor were eosinophils and basophils from the neutrophils.

TABLE 1
LEUCOCYTE COUNTS OF HEART BLOOD AND PERIPHERAL BLOOD OF THE RAT

Animals	Source of blood	Total leucocytes/mm ³	Neutrophils/mm ³	Lymphocytes/mm ³	
				Normal	After adrenal-cortical extract
18 Wistar rats	Heart Tail	28,055 ± 782* 28,166 ± 773	6,892 ± 569 5,432 ± 364	21,163 ± 568 22,732 ± 550	12,693 ± 671 13,582 ± 731
9 Wistar rats	Heart Tail	25,044 ± 624 25,122 ± 830	4,488 ± 347 4,272 ± 383	Normal 20,556 ± 872 20,851 ± 959	After saline 19,467 ± 612 20,489 ± 347
4 mongrel rats	Heart Tail	Killed by blow on head			
		21,800 ± 374 24,400 ± 867	3,706 ± 299 3,416 ± 597	18,094 ± 397 20,984 ± 540	
4 mongrel rats	Heart Tail	Cardiac puncture on exposed heart			
		21,276 ± 619 22,270 ± 772	3,627 ± 774 3,194 ± 611	17,659 ± 246 19,576 ± 906	

* Standard error = $\pm \sqrt{\frac{\sum d^2}{n(n-1)}}$

In order to determine whether heart blood and peripheral blood lymphocyte counts are affected equally by agents known to alter the lymphocyte count, 18 of the Wistar rats were given 2-ml subcutaneous injections of aqueous adrenal-cortical extract (Wilson), and the other 9 were given 2-ml subcutaneous injections of saline.

Four of the mongrel rats were killed by a blow on the head after the manner of Quimby, Saxon, and Goff and samples of heart and tail blood obtained. The other 4 mongrel rats were deeply anesthetized with ether, the heart was exposed, and blood samples were obtained directly from the beating ventricle.

Extreme care was observed in handling the animals, since Elmadjian and Pineus (*Endocrinology*, 1945, 37,

All of the data are presented in Table 1. It is apparent that there was not a statistically significant difference between the leucocyte counts of the heart blood and tail blood. The lymphocytopenia following injection of adrenal-cortical extract was of the same order of magnitude as that reported by Dougherty and White (*Endocrinology*, 1944, 35, 1-44) and was of comparable magnitude in heart blood and tail blood.

We are unable to explain the difference between our results and those of Quimby, Saxon, and Goff.

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Appeal for Scientific Literature for Austria

During a recent visit to Vienna to attend the 50th Anniversary Meeting of the Austrian Chemical Society, I learned at first hand something about the terrific problems being faced by the U. S. Information Center there. . . . Many of the libraries in Austria have either been destroyed or dispersed. Technical literature was, of course, not available during the war, and it is only returning very slowly now because of the usual difficulties of foreign exchange and world shortages. The U. S. In-

formation Center has accumulated a small technical library, and it receives quite a good selection of current technical journals, but usually only one copy of each. In many instances this is the only copy of the journal in Austria. It takes little imagination to visualize what this means to research workers and teachers. . . . All of us know the past contributions of the Austrian scientists. They can and will contribute much more in the future. Right now they need technical literature of all kinds, standard works for reference and teaching, and current literature for research background.

I want to appeal to everyone who reads this communication to do something, no matter how little, to help out on this problem. If you know an Austrian technical man, take out a subscription for him to some journal in which he is interested. If you do not know anyone personally, send a journal to one of the university or technical high school libraries. If you cannot do this, send your own journals on after you are through with them. Clean out all those old college textbooks you never look at any more. If you have books in German, so much the better, but a high percentage of the technically trained people read English and more are learning all the time, so send anything you have.

The young American woman in charge of all technical literature in the U. S. Information Center in Vienna is Miss Theresa Druml. She is a native of Milwaukee, was educated at Marquette University, and was in the WAVES during the war. . . . She said that any literature on any technical subject that we could send would be useful, and that she would be very happy to index it, sort it, and see that it is equitably distributed to all of the technical schools and universities in Austria. Therefore, if you do not have private addresses to which you can send literature, anything that you can spare should be sent either directly to: Miss Theresa Druml, U. S. Information Center, Kaerntnerstrasse 38, Vienna I, or to her attention at the U. S. Information Center, H.Q. USFA-ISB, APO 777, c/o Postmaster, New York City.

L. PATRICK MOORE

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On the Recent Frilled Shark Catch

The collection of a specimen of the frilled shark, *Chlamydoselachus anguineus* Garman, off the coast of California last June (see *Science*, July 30, p. 106) is of such an unexpected and significant nature that it deserves wide publicity. Until now, the only known specimens of this relatively rare shark were obtained from Japan and, to a lesser extent, from waters of western Europe.

The shark was caught by Pete Metson of Santa Barbara, fishing from the ship *Ermeony*, on last June 25 (probably), although an accurate record of the day was not made by the fisherman. The catch was made at a depth of 9 or 10 fathoms with a drift net (9½" mesh when stretched) which had been out all night, and the shark was still alive when pulled in at 11:00 A.M. The location was approximately Latitude 34° 23' N., Longitude 121° 03' W., which is about 22 miles south by west from Point Arguello, Santa Barbara County, California, in water 750 fathoms deep. The specimen was eviscer-

ated as soon as it was caught, then placed on ice, and frozen a few days later when brought ashore at Santa Barbara. It was partially thawed during each of three successive days when on display at the Santa Barbara Museum of Natural History.

The shark is now preserved at the California Academy of Sciences, Golden Gate Park, San Francisco. The following measurements and much of the above data were obtained from W. I. Follett, of the California Academy (the measurements were made before preservation): sex, female; total length, 1,708 mm (my original note of 1,718 mm was made several days before the animal arrived in San Francisco, and the discrepancy can be accounted for by shrinkage); thickness of body, ca. 75 mm; head, 167 mm; tip of snout to post. margin of 6th gill flap, 256 mm; tip of snout to rictus, 117 mm; tip of mandible to rictus, 117 mm; tip of snout to dorsal origin, 1,127 mm, to pectoral origin, 261 mm, to pelvic origin, ca. 889 mm, to anal origin, 1,099 mm; rows of teeth, 12-0-13 (upper), 11-1-11 (lower); teeth predominantly 5 in each row.

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Vitamin A Content of the Liver of the Frilled Shark

In a recent note in *Science* (July 30, p. 106) the occurrence of a female specimen of the frilled shark, *Chlamydoselachus anguineus* Garman 1884, off the coast of Santa Barbara, California, was reported. The vitamin A content of the liver of this rare species does not appear in the literature available to the writer; it seemed of interest, therefore, to record the available data on this specimen. The liver of the shark was an exceedingly friable, flesh-colored organ weighing 2,370 gm and containing 72% oil. Analysis of the oil in an electronic photometer equipped with a filter transmitting in the region of 328 μ yielded a value of 620 International Units/gm of oil.

While data from a single animal is of little significance, it is interesting to note that the vitamin A value here recorded is lower than that for any female shark in the list of species compiled by Springer and French (*Ind. eng. Chem.*, 1944, 36, 190-191) and compares more closely in order of magnitude with the vitamin A potency of liver oils from the rays and manta.

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TECHNICAL PAPERS

Adrenal Changes in Animals Bearing Transplanted Tumors

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The purpose of this preliminary note is to report the changes observed in the adrenal and thymus glands of mice bearing sarcoma 180 tumors. This study was undertaken in view of the accumulating evidence suggesting adrenal dysfunction in animals (1, 2, 4, 8) and patients (5, 6, 9) with neoplastic growths.

ascorbic acid levels, together with the standard errors, are given in Table 1. The values for the adrenals refer to both glands.

The values listed in Table 1 indicate that with increasing tumor size there is a progressive adrenal hypertrophy and thymus involution, the latter apparently reaching a minimum at the 9th day following implantation. A significant lowering of the ascorbic acid of the adrenal becomes apparent on the 9th day and continues to drop on the 12th day, evidently tending toward a lower level which would coincide with the death of the animals on or about the 15th day (11). The excessively high adrenal weights in the 12-day control group are probably due to coincidence with a change in the estrus cycle

TABLE 1
BODY AND ORGAN WEIGHTS OF MICE BEARING SARCOMA 180 TUMORS
(Averages and Standard Errors)

Duration (days)	No. of animals	Final body wt.* (gm)	Final tumor wt. (mg)	Thymus (mg/100 gm of b.w.)	Adrenals (mg/100 gm of b.w.)	Adrenal ascorbic acid (mg/100 gm of tissue)
6	Controls 12	20.6 ± 0.5	.....	213 ± 17.7	24.7 ± 1.9	283.3 ± 10.5
	Treated 12	21.2 ± 0.5	251 ± 34	174 ± 18.3	28.0 ± 1.7	273.0 ± 13.0
9	Controls 12	20.5 ± 0.6	.....	212 ± 12.8	25.8 ± 1.4	245.0 ± 9.9
	Treated 12	19.3 ± 0.4	445 ± 22	133 ± 11.2	32.2 ± 1.2	181.0 ± 14.9
12	Controls 12	20.1 ± 0.6	.....	211 ± 12.1	30.1 ± 1.7	270.0 ± 3.3
	Treated 12	17.9 ± 0.6	854 ± 96	140 ± 29.4	32.2 ± 3.3	174.5 ± 4.7
12	Controls 10	20.3 ± 0.7	.....	176 ± 13.1	26.5 ± 2.0	281.6 ± 15.9
	Treated 10	18.3 ± 0.7	.....	92 ± 24.0	34.1 ± 1.7	158.0 ± 8.7

* Includes weight of tumor tissue.

For the purpose of the experiment, young adult, female mice of the Carworth Farm CFW strain were chosen. In half of these, two 5-mg pieces of fresh sarcoma 180 tissue were implanted by trocar in the axillary regions; the remaining animals served as controls. The mice were kept under normal laboratory conditions, receiving Purina Laboratory Chow and tap water. Twenty-four hours prior to sacrificing, suitable numbers of animals were removed from both groups and placed in a constant-temperature room (25 ± 1° C), without food but with water to drink. On the 6th, 9th, and 12th days following implantation, the animals were killed by decapitation and the tumor tissue, thymus, and both adrenals dissected and weighed. The adrenals, having been dissected free from fat and decapsulated prior to weighing, were ground in 2% metaphosphoric acid solution and assayed colorimetrically (3) for their ascorbic acid content. The organ weights (expressed as mg/100 gm of body weight) and

of the mice (see 12), since these values were not apparent in the results of a second experiment listed in the lower part of the table.

An immediate interpretation of the above findings would be that the tumor behaves as a nonspecific stimulus inducing the changes associated with the "general adaptation syndrome" described by Selye (10). In this syndrome, stimulation of the adrenals occurs by way of the pituitary and is indicated by their hypertrophy (12) and lowered cholesterol and ascorbic acid levels (7) and by involution of the thymus (10). The findings reported here would, if interpreted in this way, coincide with the terminal or exhaustion phase of the adaptation syndrome. Comparable observations have been made by other investigators in rats bearing Walker carcinoma 256 (1, 2); the fact that the adrenal hypertrophy could not be induced in hypophysectomized rats (1) lends support to this interpretation. However, from the evidence presented here, one cannot dismiss the possibility that the

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sarcoma 180 tumor has a direct effect on the adrenal or the thymus glands or both. Studies are now in progress which will determine this point.

It must be emphasized that results obtained with transplanted tumors (particularly such atypical growths as sarcoma 180) should be interpreted with reserve. Only when similar observations are made in an inbred strain of animals bearing a spontaneous form of cancer should any general conclusions be made regarding the adrenal changes and their relation to the natural disease.

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Use of Streptomycin-dependent Strains of Bacteria for Demonstrating the Ability of Microorganisms to Produce Streptomycin¹

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Attention was previously directed (6) to the fact that streptomycin-producing strains of *Streptomyces griseus* can be identified by their sensitivity to a specific actinophage. Since this actinophage does not act upon other actinomycetes, however, the method could not be used to demonstrate streptomycin production by organisms other than *S. griseus*. For this purpose another method is suggested. It is based on the ability of certain bacteria, grown in media containing large amounts of streptomycin, to give rise to a mutant which is able to grow only in the presence of streptomycin in the medium.

The production by various bacteria of two types of mutants, one resistant to streptomycin and able to grow in

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ordinary media and another unable to grow in media free from streptomycin, was first demonstrated by Miller and Bohnhoff (2, 3) and later confirmed by Kushnick, et al. (1) and Paine and Finland (4). The latter spoke of the first type of variant as "resistant" and of the second as "dependent," to distinguish the two from the original or "sensitive," culture. These strains may be designated as *rs*, *ds*, and *ss*, respectively.

In a comprehensive study on the distribution of resistant and dependent cells of *Escherichia coli* in a broth culture (incubated for 28 hrs at 28° C) of this organism it was found that one resistant and one dependent cell were present among 1,500,000,000 normal sensitive cells. This was determined by plating the normal culture upon an agar medium containing 15 µg/ml of streptomycin. The *E. coli ds* grown on nutrient agar or in broth containing streptomycin produced the typical gram-negative rods; these were somewhat thinner and slightly longer than the cells of *E. coli ss*, the sensitive mother culture from which the *E. coli ds* was isolated. When transferred to media free from streptomycin, the *E. coli ds* failed to divide, although they increased enormously in length. Streptomycin appears to act for this culture as a growth factor essential for cell division rather than as a substrate or a nutrient, since no destruction of streptomycin takes place.

The growth of *E. coli ds* in ordinary streptomycin-containing broth could be measured by making turbidimetric readings, using a Cenco Sheard-Sanford Photometer. When the influence of streptomycin concentration in the medium upon the growth of this organism was measured, a definite correlation was obtained, up to a certain point, between the concentration of the antibiotic and the growth, as measured by turbidity, of the culture. This is brought out in Table 1. Frequently the control or streptomycin-free broth, especially when heavily inoculated, showed a certain increase in turbidity; this is primarily, at least at first, a result of the increase in the size of the cells in the inoculum rather than of the actual multiplication of the cells.

TABLE 1

RELATION BETWEEN CONCENTRATION OF STREPTOMYCIN AND GROWTH OF STREPTOMYCIN-DEPENDENT STRAIN OF *E. coli*

Concentration of streptomycin in broth (µg/ml)	Incubation (hrs)			
	10	24	51	73
	Turbidimetric readings*			
0	0	0	0	0
1	0	2	9	9
5	1	6	12	12
10	2	10	14	14
20	4	13	17	19
30	5	14	20	23
40	6	15	22	26
50	6	15	21	25
100	7	16	21	24

* One ml of a suspension of an 18-hr-old streptomycin-dependent culture (*E. coli ds*) containing 37×10^5 viable cells was used as the inoculum.

metric readings, using a Cenco Sheard-Sanford Photometer. When the influence of streptomycin concentration in the medium upon the growth of this organism was measured, a definite correlation was obtained, up to a certain point, between the concentration of the antibiotic and the growth, as measured by turbidity, of the culture. This is brought out in Table 1. Frequently the control or streptomycin-free broth, especially when heavily inoculated, showed a certain increase in turbidity; this is primarily, at least at first, a result of the increase in the size of the cells in the inoculum rather than of the actual multiplication of the cells.

A comparative study was first made of the effect of isolated and purified antibiotics upon the growth of *E. coli* (Table 2). A highly purified preparation of strepto-

TABLE 2

EFFECT OF DIFFERENT ANTIBIOTICS UPON THE GROWTH OF A STREPTOMYCIN-DEPENDENT STRAIN OF *E. coli**

Incubation of culture (hrs)	Antibiotic added				
	No streptomycin	Pure streptomycin (10 µg/ml)	Crude streptomycin-like material (10 µg/ml)	Streptothricin	
				(34 µg/ml)	(63 µg/ml)
240	0	27	30	0	0
384	0	27	30	0	0

* Growth of organism in nutrient broth is expressed as turbidimetric readings.

mycin and a crude preparation of a streptomycin-like material were compared with two forms of purified streptomycin. The latter antibiotic was used, first, because it is similar in antibacterial and in certain other properties to streptomycin, and second, because certain organisms may produce a mixture of streptomycin and streptothricin (5). The results obtained show that, whereas the two forms of streptomycin supported good growth of *E.*

TABLE 3

EFFECT OF CRUDE CULTURE FILTRATES OF DIFFERENT ACTINOMYCETES ON THE GROWTH OF A STREPTOMYCIN-DEPENDENT STRAIN OF *E. coli*

Incubation of culture (hrs)	Pure streptomycin		Filtrate 3463†		Filtrate 3495‡		Filtrate 3527§		Filtrate 3530||	
	Cells alone	Cells + SM*	Filtrate alone	Filtrate + SM	Filtrate alone	Filtrate + SM	Filtrate alone	Filtrate + SM	Filtrate alone	Filtrate + SM
24	0	0	0	0	0	0	0	0		
48	0	12	0	13	0	10	0	0		
74	0	16	1	19	0	14	0	0		
96	0	19	12	21	0	19	0	0		
120	0	20	17	21	0	21	0	1		
264	0	15	19	20	0	21	0	20	0	29
336	0	20	19	23	0	29	0	21	0	34

* Cells = suspension of streptomycin-dependent bacterial culture 8 hrs old and containing 480 visible cells/ml. Where the culture filtrates were used, the filtrate alone indicates that the antibiotic was present only in the form of the culture filtrate; filtrate + SM indicates that purified streptomycin (10 µg/ml) was also added.

† Streptomycin-producing *S. griseus* culture; final diluted broth contained 6.4 µg/ml of streptomycin.

‡ Mutant obtained from streptomycin-producing *S. griseus* culture and not producing any streptomycin; diluted broth contained 1,000 *S. aureus* units/ml.

§ Grisein-producing culture gave 388 grisein units/ml in diluted broth.

|| Streptothricin-producing cultures gave a dilution of 12-47 units of streptothricin/ml of broth.

coli ds, the streptothricin preparations did not permit any growth of this culture.

A comparative study was next made of crude culture filtrates of several antibiotic-producing actinomycetes (Table 3). Only the streptomycin-producing filtrate (3463) permitted the growth of *E. coli ds*; the supplementary addition of streptomycin to these cultures resulted in a more rapid initiation of the growth of the organism. The culture filtrates of the other three organisms, which did not produce streptomycin, did not permit the growth of *E. coli ds*; these filtrates included 3495, a mutant obtained from the streptomycin-producing *S. griseus*, but no longer producing any streptomycin; 3527, a grisein-producing culture; and 3530, a streptothricin-producing culture. The addition of streptomycin to these culture filtrates favored the growth of *E. coli ds*, thus indicating that the antibiotics found in the culture filtrates of these organisms did not interfere with the growth-promoting effect of streptomycin; at most, there was a delay, as in the case of 3527, due, no doubt, to the initial inhibiting effect of the grisein produced by this culture upon the growth of the *E. coli ds*.

Results similar to those reported in this paper have been obtained recently by R. J. Canderlinde and D. Yegian, of the Ray Brook State Tuberculosis Hospital, using an agar-streak method for the growth of streptomycin-dependent strains of different bacteria.

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Precipitin Reactions in Experimental Histoplasmosis and Blastomycosis

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Skin tests and complement-fixation reactions have been used as diagnostic aids in suspected cases of histoplasmosis and blastomycosis. The antigens employed consisted mainly of either the filtrates of broth cultures of the mycelial phase or suspensions of the yeast-like forms of the causative organisms. Recent studies by various workers have shown that the former, which is the saprophytic form grown at room temperature, was nonspecific for infections caused by the homologous fungus. The latter, which is the parasitic form when grown at 37° C, appeared to be more specific as an antigen in the complement-fixation reaction than in the skin tests.

Investigations on the precipitin reaction in histoplasmosis (3) and blastomycosis (1, 2) have been limited

and the results inconclusive. The work presented here is a report on the demonstration of precipitins in the sera of animals inoculated with either *Histoplasma capsulatum* or *Blastomyces dermatitidis*. The antigens used in this study were filtrates of broth cultures of the mycelial phase of *H. capsulatum* or *B. dermatitidis* (hereafter referred to as histoplasmin and blastomycin, respectively)

yielded 2 fractions, the first by simply adjusting the reaction to pH 4.2 or 11.2 and the second by the addition of 1 or 2 volumes of ethanol.

In this manner 4 fractions were obtained. Of the 2 fractions isolated at pH 4.2, one, designated fraction 1, was shown by chemical tests to be protein-like in nature. The second, finally obtained by the addition of 1 volume

TABLE 1
RESULTS OF PRECIPITIN TESTS PERFORMED ON THE SERA OF RABBITS INOCULATED WITH
H. capsulatum OR *B. dermatitidis**

Time after inoculation of rabbits (weeks)	Antigen dilutions	Antigens (No. of sera showing pos. reactions/No. of sera tested)											
		Histoplasmin		Blastomycin		Fractions of histoplasmin							
		H†	B‡	H	B	1		2		3		4	
						H	B	H	B	H	B	H	B
2	Undil.	6/7	1/7	6/7	1/7								
	1:10	6/7	0/7	6/7	0/7	7/7	0/7	7/7	0/7	6/7‡	0/7	4/7	0/7
	1:100	3/7	0/6	2/7	0/6	7/7	0/7	7/7	0/7	6/7	0/7	4/7	0/6
	1:1,000	0/7	0/6	0/7	0/6	5/7	0/7	7/7	0/7			3/7	0/6
	1:2,000							7/7	0/7				
3	Undil.	6/7	5/6	4/7	5/6								
	1:10	7/7	0/4	5/7	0/4	7/7	2/6	7/7	1/6	5/7	0/4	4/7	0/4
	1:100	3/6	0/4	2/7	0/4	7/7	1/4	7/7	0/6	5/7	0/4	3/7	0/4
	1:1,000	0/6	0/4	0/7	0/4	5/7	0/4	6/7	0/6			1/7	0/4
	1:2,000							4/7	0/6				
5	Undil.	5/6	5/6	1/6	6/6								
	1:10	2/6	0/6	1/6	1/6	5/6	3/6	1/6	1/6	2/6	1/6	0/6	0/6
	1:100	0/6	0/6	0/6	0/6	1/6	1/6	1/6	1/6	2/6	0/6	0/6	0/6
	1:1,000					0/6	0/6	1/6	1/6			0/6	0/6
	1:2,000							1/6	0/6				
7	Undil.	4/6	5/6	0/6	5/5								
	1:10	2/6	1/5	0/6	3/5	2/6	1/5	0/6	0/5	0/6	0/5	0/6	0/5
	1:100	0/6	0/5	0/6	0/5	0/6	0/5	0/6	0/5	0/6	0/5	0/6	0/5
	1:1,000					0/6	0/5	0/6	0/5	0/6	0/5		
9	Undil.	2/6	2/4	0/6	4/4								
	1:10	1/6	1/4	0/6	1/4	0/6	0/4	0/6	0/4	0/6	0/4	0/6	0/4
	1:100	0/6	0/4	0/6	0/4	0/6	0/4	0/6	0/4	0/6	0/4	0/6	0/4
	1:1,000					0/6	0/4						

* Sera collected prior to inoculation and 1 week after inoculation were negative throughout; sera obtained from 3 normal rabbits at each bleeding were negative throughout.

† Sera obtained from rabbits inoculated with *H. capsulatum*.

‡ Sera obtained from rabbits inoculated with *B. dermatitidis*.

§ A prozone reaction occurred with one of the sera in this group.

and 4 fractions isolated from the filtrates of broth cultures of *H. capsulatum*. Two groups of rabbits were used. One group was inoculated intravenously with the yeast-like phase of *H. capsulatum* and the other with that of *B. dermatitidis*. Three normal rabbits served as controls throughout the experimental period. All the animals were bled prior to inoculation and at weekly or biweekly intervals thereafter, and their sera examined for precipitating antibodies.

The fractionation of histoplasmin was carried out as follows: Two precipitates were obtained by adjusting the reaction to pH 4.2 and pH 11.2 after adding 1 volume of 95% ethanol to the histoplasmin. The precipitates were removed by centrifugation and subsequently dissolved in distilled water. Aqueous solutions of each

of ethanol and designated fraction 2, was polysaccharide-like in nature. Fractions 3 and 4 were isolated at pH 11.2. The chemical nature of fraction 3 has not yet been determined. Fraction 4, which was precipitated after the removal of fraction 3 by the addition of 2 volumes of ethanol, was polysaccharide-like in nature.

Precipitins were demonstrated in the sera of the infected animals by means of the so-called "ring test." One-tenth ml of antigen was carefully layered over 0.1 ml of serum in small serological tubes and the presence or absence of a precipitate noted after the tubes had stood at 37° C for 2 hrs. Only those tests showing a definite precipitate at the interface were regarded as positive. All others were recorded as negative.

In Table 1 the sensitivity and specificity of histo-

The Occurrence of Temperatures Unusual to American Lakes¹

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Lake waters are known to exhibit two major temperature characteristics of primary ecological significance. One of them is the existence of seasonal changes characterized by surface-bottom mixing in the spring and fall seasons, with intervening periods of relatively stable thermal conditions. The second widely occurring phenomenon, known since the work of Simony about 1850, is the rapid decrease in temperature throughout an intermediate water layer, termed the *thermocline* by Birge in 1897. Above the thermocline is a layer called the *epilimnion* that usually extends to a depth of about 12-24' or more below the surface, while below it is the *hypolimnion* layer in which the water, under normal conditions, is disturbed only during the spring and fall seasons by the surface-bottom mixing of the waters of the lake.

The morphological, metabolic, and physical-chemical properties of different lakes are directly related to variation with respect to these two dominant characteristics. This paper describes briefly three departures from the temperature conditions that usually exist in lakes. They are as follows: (1) a measurable increase in temperature from the top to the bottom of the hypolimnion; (2) the permanent stagnation of the hypolimnion throughout the year; and (3) the prolonged existence of the upper limit of the epilimnion to within about a foot or two of the surface.

Observations were made at Sodon Lake, Oakland County, Michigan (Bloomfield Township, Sect. 20; lat. 42° 19', long. 83° 17') during the period May 1947-May 1948. The first record of a temperature increase in the hypolimnion in this lake was made on May 22, 1947, by Stanley A. Cain and the senior writer. Since that time an intensive study has been made of the dominant physical and chemical properties of this lake in an effort to associate the unusual thermal properties of the water layers with related phenomena.

Sodon Lake is a small, ice-block lake from 50' to 60' in maximum depth and 5.7 acres in area at the surface, 3.2 acres within the 20' depth contour, and 1 acre within the 40' isobath. The volume development of the lake is 1.21, indicating that the basin closely approximates a cone.

Considerable protection from wind action is afforded by the surrounding wooded hillsides and, to a lesser ex-

¹ We are indebted to Gustavus D. Pope for the use of his lake and for numerous other courtesies. Acknowledgment is also made to S. A. Cain and F. T. Knapp for cooperating with the senior writer on several occasions in taking temperature records.

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tent, by the red maple-tamarack swamp forest which occupies the shore zone. The littoral area out to a depth of about 12' is covered with a dense growth of *Chara* including some *Potamogeton* and white and yellow water lilies. Beyond the 12' contour there is some *Nitella* and bottom-growing moss of the genus *Fontinalis*. In this area there are very few benthic animals and in the greater depths, rich in hydrogen sulfide, practically no signs of animal life.

Throughout all months of the year there is a slight increase in temperature from the 30' level, near the upper part of the hypolimnion, to the bottom. In winter and early spring the increase is from a range of 39.2–39.7° F at 30' to one of 39.9–41.1° F at the bottom level. By midsummer the water at the 30' level has warmed up slightly to, on the average, about 40.4° F, and there is possibly a slight increase in the temperature of the water immediately above the bottom to about 40.5–41.1° F. The amount of thermal change from the top to the bottom of the hypolimnion varies at any one time from a few tenths of a degree to 1.6° F. Any seasonal variation in the temperature of the waters below 35' is at best only a matter of tenths of a degree Fahrenheit and difficult to define with certainty, using a Foxboro thermometer. The slight thermal gradient increasing toward the bottom, and the relatively great stability of the bottom temperatures is illustrated in Fig. 1. The fall and spring over-

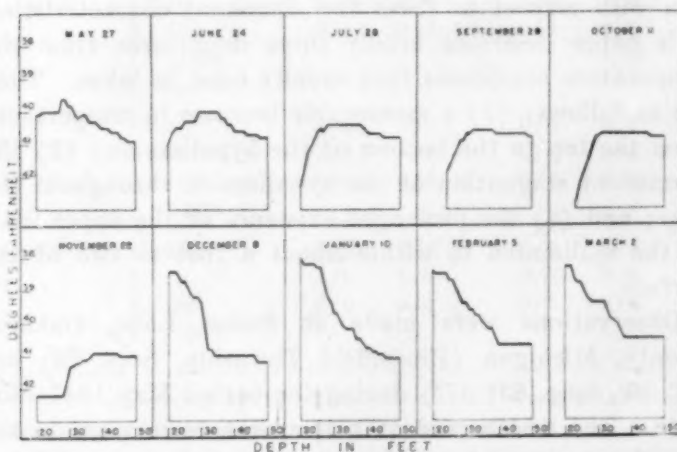


FIG. 1. Monthly variations in the extent of the temperature inversion in Sodon Lake, Oakland County, Michigan, during 1947–48.

turns in 1947–48 did not penetrate below 30–35'. Depths of around 30' represent ecotone levels that are seemingly the meeting points of shallow and deep-water thermal influences. The particular fall season will determine the distance below the 30' depth that cold, surface water conditions may penetrate. Likewise, factors operating in the hypolimnion will probably vary from year to year with respect to their influence on the temperature of the waters near the 30' level. The upper limit of the hypolimnion ranged from about 16' in late May 1947 to 29' on November 22, just preceding the complete disappearance of the thermocline.

The third unusual condition found in Sodon Lake is the existence of the thermocline within 1' or 2' of the

surface during a prolonged period. The lower limit of the thermocline dropped from a depth of about 15' in late May to around 25' in early September. The decrease in temperature from the top to the bottom of the thermocline was approximately 19° F in late May and from 19° to 42° F during August and early September. The magnitude of the average drop in temperature per foot increase in depth throughout the thermocline ranged from 1.2 to 2.2° F during the period May 27–September 1947. Below 30' the temperature range was from 39.2° F, the lowest temperature at the 30' level, to about 41.1° F, which was the highest bottom-water temperature.

Two other comparable instances of temperature inversion, known as dichothermy, have been reported in American lakes, one being Fayetteville Green Lake, Syracuse, New York, studied by Eggleton (1), and the other, Lake Mary, Wisconsin, observed by Juday, Birge, and Meloche (2). In Europe and Asia the temperature inversion phenomenon has been reported for a number of lakes in Austria, Germany, and Japan (3).

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On the Origin of Virus Phosphorus¹

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Knowledge of the biological precursors of virus nucleic acid and protein is essential to the understanding of the mode of virus reproduction. Bacteriophages infect an autonomous host cell of well-elucidated metabolic pattern and viable on synthetic medium and thus are very suitable systems for isotope tracer studies of the origin of virus constituents and of the extent to which these are directly derived from the host.

The isolation from broth lysates of purified *Escherichia coli* bacteriophage T₆r* with normal infectivity but containing radioactive phosphorus has already been reported (3). Isotope studies described in this paper demonstrate that when phage is propagated in bacteria maintained in a chemically defined medium, the medium itself can be the ultimate source of 70% of virus phosphorus. The remaining virus phosphorus is derived directly from the bacterial host, chiefly from some P₁ fraction other than low-molecular-weight, acid-soluble compounds.

For these experiments the phage was harvested in

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* We are indebted to D. Gordon Sharp, of the Department of Surgery, Duke University School of Medicine, for electron microscope and ultracentrifuge investigation, and to E. A. Evans, Jr., University of Chicago, for aid and encouragement in this work.

centrifuge and isolated by repeated differential centrifugation. The details of the procedure will be published separately. The purified phage had an average activity of $10^{15.89}$ gm N/infectious unit when measured by plaque count assay. For practical reasons chemical characterization was limited to unlabeled virus. In the electron microscope the phage exhibited typical tadpole-shaped particles with crescent-shaped markings in the "head." Absorption photographs in the ultracentrifuge revealed two principal sedimenting boundaries with sedimentation constants of 1,034, and 787 Svedberg units) similar to those reported for ultracentrifugally isolated T_2 bacteriophage. On electrophoresis in the Tiselius apparatus the labeled virus migrated with a single boundary over the range studied, pH 5.1-7.6. The stability range for activity was pH 5-8.6. Partition of the P of purified T_2 phage by the methods of Schneider (5) of Schmidt and Thannhauser (4) revealed that desoxyribonucleic acid (DNA) is the chief P constituent.

sion is in accord with recent observations of Cohen (1) on bacteriophages T_2r^+ and T_4r^+ grown in synthetic medium. In Experiment 1 the relative radioactivity of virus to medium demonstrates that some 70% of the virus P ultimately came from the medium by a path, presumably bacterial, not yet fully elucidated. Conversely, in Experiment 2 the data indicate that bacterial P was the precursor of only about 23% of virus P. In Experiment 3 with differentially labeled bacteria it is significant that, although the relative radioactivity of bacterial acid-soluble P (compared to total bacterial P) was reduced by one-half, the relative radioactivity of phage to bacteria was undiminished.

Cohen has reported that ribonucleic acid did not turn over in bacteriophage-infected cells (1). Our experiments indicate that gross changes in the specific radioactivity of bacterial acid-soluble phosphorus are not reflected in the radioactivity of the virus. It seems unlikely that phospholipids would materially be involved in virus synthesis. The possibility remains that bac-

TABLE 1
RADIOACTIVITY OF BACTERIOPHAGE T_2r^+ GROWN ON *E. coli*
WITH CELLS OR MEDIUM CONTAINING P^{32}

Bacteria	Medium	Specific radioactivity*				Relative radioactivity†			
		Bacteria		Virus		Virus		Virus	
		Total P	DNA‡	Acid-soluble	Total P	DNA	Medium	DNA Bact.	Total P Bact.
Unlabeled	17.1	0	0	0	11.9	12.9	69.5	...	...
Labeled	0	80.6	75.8	80.6	18.2	19.6	...	25.8	22.6
Differentially labeled	0	348	415	195	108	128	...	30.8	31.0

* Counts/min/μg of P.

† Ratio of specific activities × 100.

‡ DNA = desoxyribonucleic acid.

ever, significant amounts of acid-soluble P and RNA, and of ribonucleic acid, have been found in preparations that yield a single boundary in electrophoresis.

Virus containing P^{32} was isolated by the above procedure after multiple infection of labeled or of unlabeled bacteria. Three types of experiments were performed in synthetic (lactate) medium using (1) labeled cells in medium containing P^{32} , (2) washed labeled cells in unlabeled medium, or (3) differentially labeled cells in unlabeled medium. In each instance the bacteria were multiply infected with three phage particles per bacterial cell to produce a single virus generation without further bacterial growth. Labeled cells were used by growing bacteria in medium containing $1 \mu\text{C}$ of P^{32} /ml. Bacteria differentially labeled in several phosphorus fractions were obtained by allowing labeled cells to metabolize lactate for 5 hrs in nitro-free, nonradioactive medium. The results are given in Table 1.

From the three experiments it can be seen that under these conditions the P of the virus was chiefly derived from inorganic phosphate of the medium. This conclu-

terial desoxyribonucleic acid is the major source of the bacterial contribution to virus phosphorus. The fact that the bulk of virus phosphorus is derived from the medium is in accord with our calculations, which indicate that at the time of infection bacterial DNA content is sufficient to account for only a third of the DNA contained in the liberated phage. Although these experiments indicate that the total bacterial acid-soluble P appears to make a negligible contribution to phage P, the data do not preclude the participation of an active low-molecular-weight phosphorus intermediate in virus reproduction. Rather, it appears probable that virus infection potentiates P absorption and metabolism by the host, directing it exclusively toward the synthesis of virus.

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Hydraulic Device for Raising and Lowering Mercury in Gas Analyzers

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The Shepherd apparatus (1) is used almost exclusively for gas analysis in this laboratory. As marketed, this employs the conventional leveling bulb method for raising and lowering the mercury in the burette. The rate of flow of the mercury is controlled with a double-bore stopcock at the bottom of the burette. The large bore of the stopcock is used for rapid passage of the mercury and the small bore for fine control.

When a large number of samples are analyzed, the raising and lowering of the mercury-filled leveling bulb becomes tiring. There is also the possibility of spilling the mercury from the leveling bulb during this action.

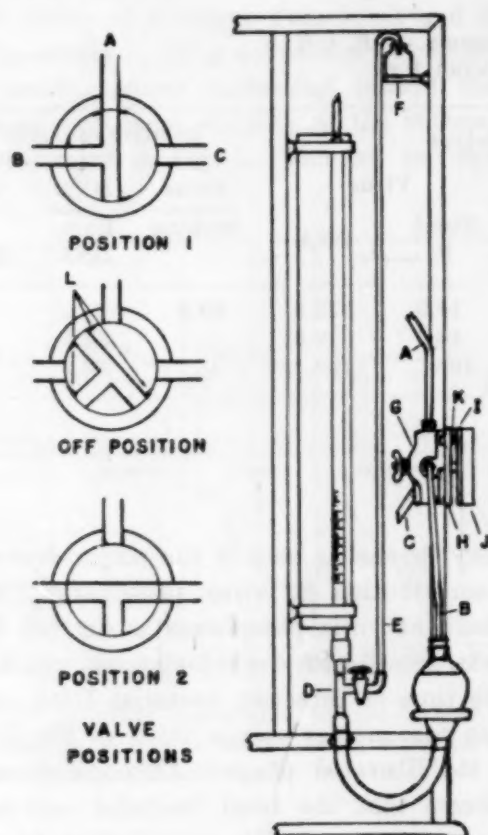


FIG. 1

A satisfactory modification of the leveling arrangement has been designed in this Laboratory for use with the Shepherd apparatus. House water pressure is utilized for raising the mercury, and a three-way valve controls the flow. This principle is generally applicable to other types of gas analysis apparatus in which mercury is used for displacing the gases.

The following is a description of this arrangement as illustrated in Fig. 1:

The double-bore stopcock at the bottom of the burette is replaced with a glass T (D), the side arm of which contains a stopcock which, in turn, is connected to a glass

tube (E) rising parallel to the burette and extending slightly above the highest outlet in the apparatus. At this point the tube is turned down, and an open bottle (F) is supported under the opening to catch the overflow. The lower end of the T is connected to the leveling bulb with a short piece of rubber tubing. The leveling bulb is secured on an approximate level with the T.

A three-way control valve (G) is mounted by means of a flat support plate (H) to the frame of the apparatus at a convenient height directly above the leveling bulb. One outlet of the valve (B) is piped and sealed into the top of the leveling bulb, the other outlet (C) being piped to a drain or catch basin. The inlet of the valve (A) is connected to the house water system. For this purpose copper tubing with an outside diameter of $\frac{1}{2}$ " was used from the water supply line to the apparatus and then reduced to $\frac{3}{8}$ " O.D. at the valve inlet.

The three-way valve used was a Minneapolis Honeywell "Type SO 47 B" diverting switch (three-pipe). Although normally used as an air switch, it has proved to be entirely satisfactory for this application. The plastic hand-lever of the valve was replaced with a $\frac{1}{2}$ " brass disc (I), approximately $2\frac{1}{2}$ " in diameter. The spiral brass bushing of the plastic hand-lever was removed and soldered into the center of the brass disc. A plastic grip (J) approximately $\frac{1}{4}$ " thick was mounted on the brass disc to afford a better hand grip for control of the valve. The hex nut over the tension spring on the end of the valve core was replaced with a wing nut to facilitate removal of the core for lubrication. The valve core is limited to a 90° arc by stops on the valve body and a pin projecting from the valve core. The two open positions of the valve are at the extreme ends of the arc, and the halfway mark at 45° is the "off" position. In order to establish the "off" position while operating the valve, a $\frac{1}{2}$ " "bullet catch" (K) is mounted through the support plate so that the plunger of the "catch" slightly depressed, rides against the brass surface of the hand control disc at a point approximately $\frac{1}{4}$ " from the periphery. With the valve in the "off" position, a slight depression is made in the surface of the control disc directly under the plunger of the catch. When this position is reached during operation, the plunger will drop into the depression with an audible sound. This position can also be "felt" as the plunger drops into the depression.

The leveling bulb should hold sufficient mercury to fill both burette and side tube, with enough remaining to form a trap between the leveling bulb and the burette. When the valve is rotated clockwise from the "off" position to position 1, the water pressure forces the mercury up both the burette and the side tube. When the valve is rotated counterclockwise from the "off" position to position 2, the pressure of the mercury column forces the water through the drain outlet in the valve.

For fine control of the flow, very narrow V cuts are made into the body of the valve core leading into the holes, as indicated on the valve core positions.

The rate of rise and fall of the mercury in the side tube relative to that in the burette is adjusted by

...opecock between them. For best operation this rate should be slightly slower than that in the burette during rapid flow of the mercury. This will tend to prevent overshooting in the burette and the absorption pipettes when the valve is returned to the "off" position, since, after rapidly raising the mercury in the burette and then stopping, the mercury must fall slightly to come in equilibrium with the side tube. Likewise, the mercury must rise slightly in the burette (and consequently the liquid must drop slightly in the absorption pipette) after a rapid drop.

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Heteroplastic Grafts

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At the present time it is generally believed that grafts between unrelated plants are impossible. Very little literature is available on this subject. Funck (1) in 1929 made many successful grafts within the Solanaceae and within the Cactaceae. Since then, intrafamily grafts have received much attention, especially those within the Solanaceae. The significant work of Camus in 1943 has been well reviewed by Gautheret (2). By successfully grafting buds of chicory on root fragments of the same species grown *in vitro*, Camus demonstrated the histogenic action exerted by the buds on subjacent tissues. Funck (1) and Simon (3) secured a graft between *Solanum melongena* (Solanaceae) and *Iresine Lindenii* (Amaranthaceae) which, so far as can be determined, is the only record of a successful graft between unrelated plants up to the present.

Stock-seion grafts using white sweet clover, *Melilotus alba* (Leguminosae), and sunflower, *Helianthus annuus* var. Giant Russian (Compositae), were made using the clover as scion and the sunflower as stock. Six cleft grafts were made on two-month-old sunflower plants at the following positions: (a) below the cotyledon attachments, (b) immediately above the cotyledon attachments, (c) above the first pair of true leaves, and (d) above the second pair of true leaves. The scions were cut from the current growth of two-year-old clover plants, using both stem tips and lower regions which included at least one node. The scions, as shown in Fig. 1, were grafted into the pith parenchyma of the stock, thereby preventing juxtaposition of cambial or vascular elements.

Within a week, leaves of the scion unfolded on all 6 grafts, and after 3 weeks all had the appearance of normal healthy plants. Since the valid criterion of a true graft depends upon vascular connection between stock and scion, histological examination of one of the grafts was made after 3 weeks to determine if this had taken place. This examination showed (Fig. 1) the differentiation of xylem and phloem strands in the pith parenchyma

of the stock from one point on the contact surface toward the vascular elements of the stock, thus forming a true vascular connection. A second graft, which had been allowed to develop for 11 weeks, showed that, with further growth of the two graft partners, a more extensive development of the vascular connection resulted. In the older graft, vascular connections were present at many places along both contact surfaces of the graft.

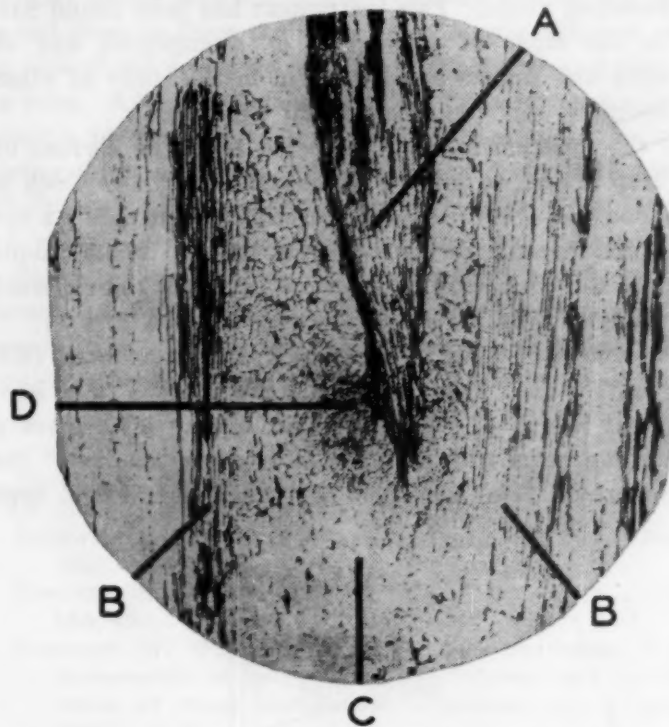


FIG. 1. A, scion; B, vascular bundles of the stock; C, pith parenchyma of the stock; D, region of vascular differentiation.

In the case of clover and sunflower it would thus appear that successful grafts can be obtained. A true vascular connection between the graft partners is initiated at an early stage, and scions have continued to grow with normal vigor for over 5 months. Experiments designed to ascertain how widespread are the possibilities of heteroplastic grafts have been started. Thus far it has been found that *Melilotus alba* can be successfully grafted on *Nicotiana Tabacum* (Solanaceae). Sections taken from this graft after 11 days show divisions in pith parenchyma cells of the stock proceeding from the contact line of the graft toward the vascular elements of the stock. Other heteroplastic grafts have been made including cowpea on tomato, clover on geranium, and tomato on geranium. Although these have not yet been examined histologically, they appear to be successful.

These results clearly show that we may abandon the idea that grafts between unrelated plants cannot be made. In addition, the method of grafting the scion into the relatively undifferentiated pith parenchyma cells of the stock becomes a useful technique in the study of vascular differentiation.

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A Photoelectric Drop Counter¹

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A photoelectric counter (Fig. 1) has been devised which, it is hoped, will eliminate the numerous operating difficulties presented by currently used instruments designed for counting drops. This instrument has been found useful in the study of the action of chologogues and of diuretics and can be equally useful in the study of other physiological and pharmacological processes.

In this instrument, light reflected from the surface of the drop is used to initiate an electrical impulse which is amplified and recorded on the usual kymograph. As the drop falls through the beam of light there will be a unique point in the trajectory of the drop at which the reflected beam passes through the slits S_1 and S_2 (see Fig. 1).

The source of light is a 150-watt projection bulb (GE type T-8) placed just outside the focal point of a lens, the focal length of which is about 6 cm. This gives a converging beam with an angle of convergence of 35° for outside rays. The photocell is a high-vacuum GE type

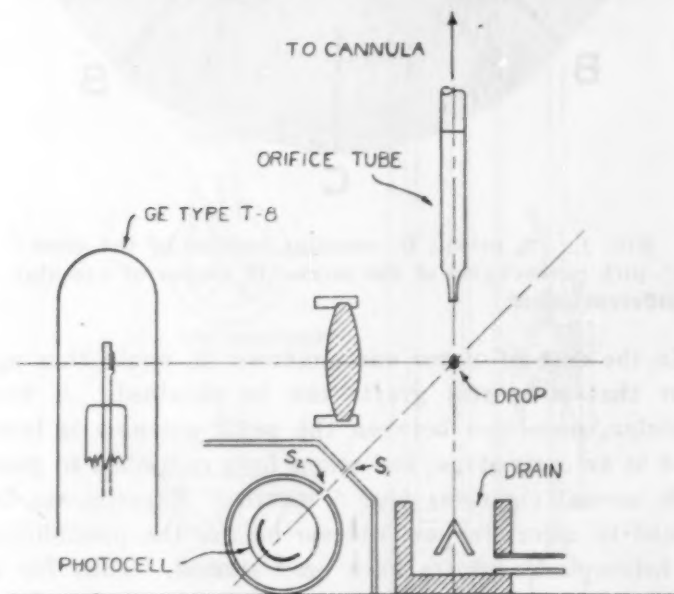


FIG. 1

FP-22 with S-1 response operated at 250-v anode potential and coupled to the amplifier with a 10-megohm load resistor.

The amplifier (Fig. 2) is a conventional resistance-capacitance coupled, single-sided circuit utilizing two 6F5-GT tubes with a total voltage gain of about 5,000. The output stage is a 6C5 tube with a relay in the plate circuit. By means of a variable bias from the power supply, the 6C5 is biased above cut-off, and this variable bias provides a means of varying the over-all sensitivity of the amplifier. The photocell is coupled to the amplifier in a forward circuit arrangement. The relay in the 6C5 plate circuit is a four-pole, single-throw type closing at 2.5 Ma and can be used to close any type of recording

¹ This work was supported by a grant from the American Cyanamid Analgetic Fund.

circuit. In the present instrument it closes the 115-v a-c primary circuit of a transformer, the output of which is 8 v and is used to drive a solenoid timer.

This instrument is very simple in operation, requiring only turning on the switch and clamping in the orifice tube. The latter is removable to permit cleaning. As the beam of light is about 4 mm in diameter at the place at which the drop passes, the adjustment of the orifice tube is not critical.

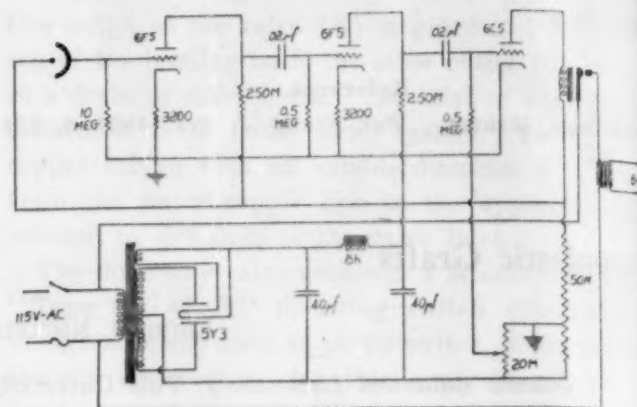


FIG. 2

With an orifice of 2 mm, this instrument is capable of handling some 30 ml of fluid/min, which is broken into discrete drops. There is no lower limit, and the instrument is capable of being run for an indefinite period. Because the amplifier is R-C coupled, a solid stream will not be recorded. At a capacity of 30 ml/min the drop rate is about 500/min. Using larger drops at this counting rate, a larger volume of fluid may be recorded. The size of drop is variable over a wide range, and operation is in no way dependent on viscosity, color, or opacity of the fluid.

Preparation of Acellular Homogenates From Muscle Samples

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The preparation of acellular homogenates from tissue samples is required in certain biochemical experiments. For softer tissues, this problem has been met with varying degrees of success by such methods as grinding with sand or glass powder, forcing the tissue past the wall of a cylinder and a tight-fitting, motor-driven plunger, grinding the tissue after mincing and freezing it, or homogenizing it in a Waring blender (1-4).

None of the individual methods listed is adequate for preparing acellular homogenates of tougher tissues, such as skeletal or cardiac muscle, which can be assayed quantitatively.

The method herein described is based upon the complete pulverization of a tissue sample at a temperature of approximately -70° C by pounding and the subsequent homogenization of any desired amount of the pulverized

sample in a measured volume of water by means of stainless-steel cylinder and closely fitting rotating plunger. This method permits one to reduce any body tissue, with the exceptions of connective tissue and integument, to an acellular state with negligible losses of the original sample.

The apparatus shown in Figs. 1 and 2 was found to be satisfactory for the pulverization and homogenization of muscle samples weighing up to approximately 3 gm.¹

The wooden box (A) in Fig. 1, with the stainless-steel mortar (B) in place in a steel anvil (H), is packed with dry ice and covered. The stainless-steel pestle with wooden handle (C), steel spatula (D), and a pair of forceps are inserted into the dry ice through a hole in the cover (G), and the box and its contents are allowed to reach a state of temperature equilibrium. The Lucite cover (E) and the movable Lucite guard (F) are put into place and clamped to prevent the accumulation of frost on and around the mouth of the mortar. The tissue sample is placed in the dry ice (under cover J) and also allowed to reach a temperature approximating -70°C . After 5 min or so, the sample is rapidly transferred from the dry ice to the mortar with the prechilled forceps. The cover used to close the Lucite guard is removed, and the

a glass boat for weighing. The weighed sample is then washed off the boat with a measured volume of distilled water or other extracting medium, into a Cori-type (4), stainless-steel, homogenizing tube (Fig. 2, 1), the upper portion of which has been machined with a collar for centrifugation (Fig. 2, 5).

The homogenizer tube is placed in a cup containing cracked ice; the plunger (Fig. 2, 2) is attached to a wall-mounted, 1,550-rpm, 1/30 hp motor (Fig. 2, 3). The contents of the tube are homogenized by moving the tube up and down to force the water and tissue suspension past the wall of the power-driven, rotating plunger and that of the tube. After the homogenate has been forced past the rotating plunger approximately 10 times, the tube containing the homogenate is inserted into a standard 50-ml #2 International centrifuge trunnion ring (Fig. 2, 4) and centrifuged. Microscopic examination of the precipitated muscle residue after centrifugation shows the absence of the occasional intact cells previously mentioned. The supernatant fluid may be used directly for quantitative estimations of extracted tissue components.

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A Microextraction Procedure for Phenol Determination¹

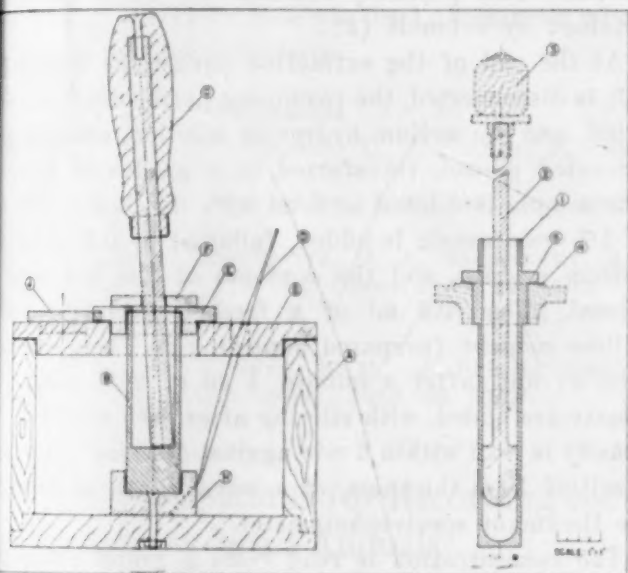
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Difficulties were encountered in applying the Theis and Benedict (4) technique for phenol determination to fluids resulting from incubation of phenol with tissue slices and other tissue preparations. The greatest difficulty is due to the presence of interfering substances. In the case of slices, the concentration of such substances is rather low, and it is possible to determine phenol directly if proper precautions are observed. When mince, homogenate, acetone powder, or other similar tissue preparations are used, there are two main sources of error: (a) the presence of much higher concentrations of interfering substances, and (b) the adsorption of phenol to the protein precipitate in deproteinizing the sample. This second observation is in accord with the findings of Voinar and Babkin (5) regarding the recovery of phenol added to serum.

¹ This work was supported by a grant-in-aid from the U. S. Public Health Service.

² With the technical assistance of Marvin Bierenbaum.



FIGS. 1 & 2

sample is pounded with the pestle. The guard prevents little tissue chips from bouncing out of the mortar. After the first 5 or 10 blows, most of the muscle sample is shattered and free of its tendinous attachments, the water portion of which can be removed as arborized bits by means of the chilled forceps. After 20-40 more blows, the sample is reduced to a uniformly fine powder. Microscopic examination shows most of the powder to be cell free, although a few clumps of intact cells can be found. This preparation is adequate for qualitative extraction of the tissue.

For quantitative extraction, the sample is transferred to

Laurence H. Crisp, chief of Research Equipment Design and Fabrication, and John De Broske, chief instrument maker, assisted in the design and construction of this apparatus.

The solution to the first difficulty lies in the isolation of phenol. For this purpose Schmidt (2) has used continuous extraction with ethyl ether, and Deichmann and Schafer (1), extraction with ethyl ether followed by steam distillation. In both techniques the proteins were removed by precipitation with tungstic acid. Schmidt obtained only 76% recovery of phenol added to blood; Deichmann and Schafer obtained a higher recovery with their method.

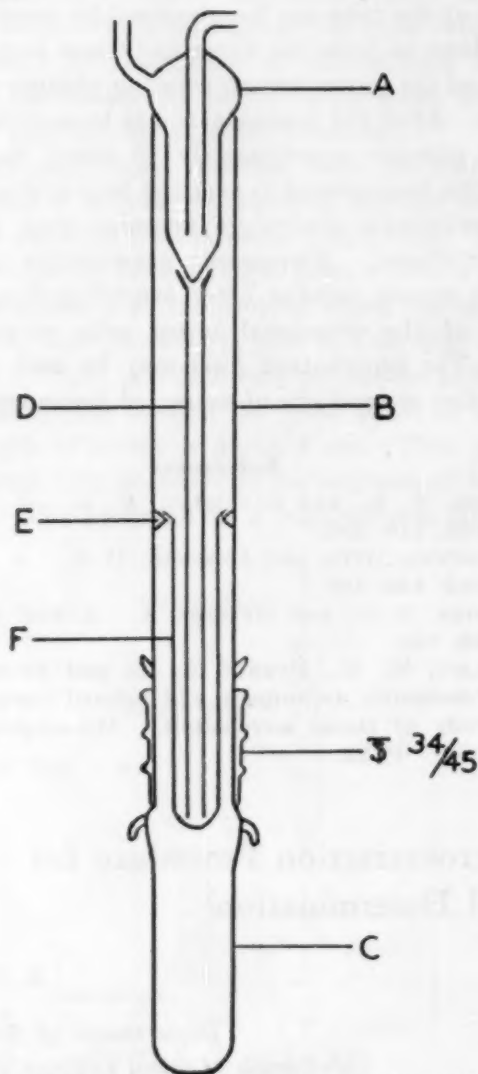


FIG. 1. Microextractor drawn to scale, one-fourth actual size.

For their extraction procedure, Schmidt and co-workers (3) used a modified Kutscher-Steucl extraction apparatus. We have devised a new type of microextractor based on the same principle (Fig. 1). The extractor consists of a finger-type condenser (A) resting within the opening of the middle piece (B) and centered by spikes. Inside this middle piece a thimble (F), which can be easily made from a test tube, hangs from two spikes (E). A long-stem funnel (D), with a dented lower end to permit passage of the solvent, rests on the bottom of the thimble. The thimble and funnel are introduced from the bottom of piece B and hung by rotation. The middle piece (B) is fastened with springs to the bottom part (C) by a 34/45 standard joint.

The dimensions of the thimble and funnel may be varied to accommodate the volume of fluid to be extracted. The specific gravity of the solvent used is an important factor to be considered.

For the extraction of phenol, the sample is placed in the thimble (F) and the funnel (D) introduced. The unit is then hooked inside the middle piece (B) and the condenser (A), so placed that the tip will keep the funnel centered. Two ml of approximately 0.1 N sodium hydroxide is placed in the bottom part (C), which is attached to the middle piece and fastened with springs. The condenser is lifted slightly and petroleum ether is poured through the funnel until it overflows from the thimble, after which an additional 5 or 6 ml is introduced. It is advisable to keep the level of the aqueous phase 1.5–2 cm below the rim of the thimble in order to avoid mechanical carrying over of the sample. The funnel and thimble must be loaded with solvent so that the circulation of solvent will begin as soon as it condenses and drops into the funnel; otherwise, the solvent will be in the thimble and funnel, resulting in poor extraction.

To start the extraction, the bottom part of the extractor is immersed in a water bath at about 85° C.

We have found that 100% of the phenol is extracted in 3 hrs. The sodium hydroxide placed in the bottom part (C) binds the phenol extracted by the petroleum ether. This is necessary to achieve complete extraction because some phenol volatilizes and circulates with the solvent. This probably accounts for the low recovery obtained by Schmidt (2).

At the end of the extraction period the bottom part (C) is disconnected, the remaining petroleum ether evaporated, and the sodium hydroxide solution, containing the extracted phenol, transferred to a graduated test tube. The sample is diluted to 7 ml with distilled water, 1 ml of 1% gum acacia is added, followed by 0.5 ml of 5% sodium acetate, and the contents of the test tube are stirred. Then 0.5 ml of a freshly diazotized *p*-nitroaniline reagent (prepared according to Theis and Benedict, 4) and, after a minute, 1 ml of 20% sodium carbonate are added, with stirring after each addition. The density is read within 5 min against distilled water, using a cell of 1-cm thickness, at a wave length of 5,000 Å the Beckmann spectrophotometer.

The concentration is read from a graph obtained by plotting several known concentrations of phenol against the observed densities. The stock phenol solution was standardized iodometrically.

A straight line is obtained with quantities of phenol up to 50 µg, indicating conformity with Beer's law.

Recovery of phenol was within ±5% of theory for values between 50 and 200 µg, ±10% for values between 10 and 50 µg, and ±25% for 5 µg.

As much as 50% of added phenol was lost when the proteins of a 10% liver homogenate were precipitated with trichloroacetic acid and the analysis carried out on the supernatant obtained by centrifugation.

It was necessary, therefore, to extract the homogenate or acetone powder without removal of protein. The thimbles containing the homogenate or acetone powder samples were placed, prior to extraction, in a boiling

* Purified by treatment with concentrated sulfuric acid; the portion distilling below 45° C is collected.

placed bath for 5 min. This treatment served a double purpose: (a) to stop the enzymatic reaction and (b) to emulsification of the solvent. If an emulsion is formed, a mechanical carrying over from the thimble is avoided, and the extracted phenol is contaminated with interfering substances.

When using tissue slices (200 mg of rat liver), it is possible to precipitate the proteins with trichloroacetic acid without loss of phenol. In this case it is necessary to neutralize the trichloroacetic acid before extraction; otherwise, the phenol will not be completely extracted. Neutralization is carried out by addition of 20% sodium hydroxide until the fluid remains slightly acid. This is completed by addition of approximately M phosphate buffer pH 7. At pH 7 the phenol is free and can be extracted, whereas at higher pH it may be partially or completely bound.

After extraction of free phenols, one desires to remove conjugated phenols, the thimble and funnel are removed. Conjugated phenols are hydrolyzed by placing thimbles in a boiling water bath for 15 min after addition of 0.25 ml of concentrated hydrochloric acid. If trichloroacetic acid has been used, the thimble and funnel are replaced in the extractor, and the extraction and determination are carried out as indicated for free phenols. If trichloroacetic acid was used, the sample must be neutralized as indicated above.

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Convenient Apparatus for Recording the Blood Pressure of Small Animals

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For physiological and pharmacological investigations it is often more convenient to use small animals, such as mice and guinea pigs, since the food and housing problems are less than for larger animals. It is often desirable to measure the blood pressure of these animals, but the application of currently used methods to small animals is sufficiently difficult that this aspect of many research problems is neglected. The Hamilton (2) optical manometer is a precision instrument that will measure the blood pressure of the smallest animals (5) and avoids the error introduced by the cuff methods sometimes employed for rats (4). However, the instrument is difficult to set up and maintain by unskilled personnel, it must

be used in partial darkness, and, since it records on photographic paper, there is a considerable time lag between administration of a drug and observation of the results. Recently, the use of strain-gage manometers recording through a string-type electrocardiograph galvanometer has been suggested (1), but this also suffers the difficulties inherent in any method of photographic recording.

If only changes in mean blood pressure are desired, these can be obtained easily by the use of Lambert-Wood (3) strain-gage manometers,¹ with current supplied by a 7.5-v A battery² and recording in ink on a continuous strip chart by a General Electric photoelectric recording microammeter (Model 8CE1DJ15 or 8CE1DJ11). The apparatus is simple and rugged, and can be operated in any location with 110-v, 60-cycle current. The record is always visible, and annotations can be made on it in ink or pencil at any time (Fig. 1). It is not subject to de-

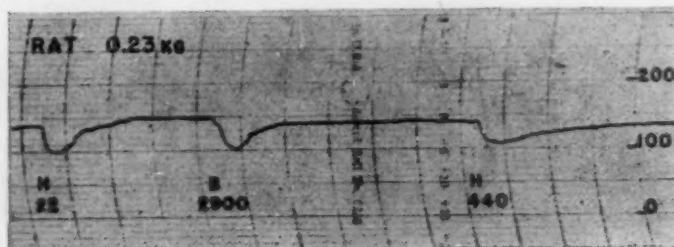


FIG. 1. Record of male rat: 250 mg of Na barbital/kg; 22-gage hypodermic needle in carotid artery. Injections of drugs made into external jugular vein. Blood pressure in mm Hg, ordinate; time, in minutes, abscissa. Twenty-two μ g of histamine base/kg given at H, followed by 2,900 μ g of diphenhydramine hydrochloride ("Benadryl")/kg at B, followed by 440 μ g of histamine at second H. Record shows that this dose of diphenhydramine is able to antagonize the vasodepressor activity of 95% of a dose of histamine.

struction by folding, warmth, or scratching with fingernails or gritty substances, as are some of the electrolytic and plastic recording papers, and it can be mounted easily with glue or rubber cement. Although the GE instrument is a high-speed recorder, the electronic circuit is slow enough that damping of the systolic-diastolic pulse to mean blood pressure occurs. If systolic and diastolic blood pressure and contour slopes of the arterial pressure curves are needed for a given research problem, only the optical recording, small-diaphragm manometers of the Hamilton type are adequate; but if only information concerning mean blood pressure is desired, as is often the case in the bioassay of drugs, this apparatus provides an improvement over existing methods.

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¹ PS-8-350 manometer, Statham Laboratories, 8222 Beverly Boulevard, Los Angeles 36, California.

² Burgess G5, Burgess Battery Company, Freeport, Illinois.

Book Reviews

Centennial symposia, December, 1946. (Contributions on Interstellar Matter, Electronic and Computational Devices, Eclipsing Binaries, The Gaseous Envelope of the Earth.) Cambridge: Harvard College Observatory, 1948. Pp. viii+385. (Illustrated.) \$5.00.

The four centennial symposia, in commemoration of the beginning of active telescopic research at Harvard University in 1846, comprise 24 invited papers. Made available now in this seventh of the series of Harvard Observatory monographs, these contributions together depict the current status of research over a widely representative part of contemporary astronomy.

Since 50% or more of the matter in the galaxy may be strewn in interstellar space as dust and gas, it is fitting that the first 8 papers should comprise a symposium on interstellar matter. The interstellar dust reveals itself principally by a reddening of distant stars in our own galaxy. Stebbins discusses photoelectric measures of a similar space-reddening within other galaxies. He also presents evidence of the first penetration, in the infrared, of the dust clouds concealing the center of our galaxy. Other contributions deal with the optical properties of the interstellar dust particles, the distribution of their sizes, their chemical composition, and their interaction with the interstellar gas. Greenstein discusses spectroscopic evidence for the direct interaction of condensations in the interstellar medium with stars embedded in them. Papers by Bok, Spitzer, and Whipple concern the evolution of discrete dust clouds; their development is shown to be capable of generating stars and, possibly, planetary systems.

In the symposium on electronic and computational devices of interest to astronomers, Kron contributes a paper on the optimum design of stellar photoelectric photometers. Whitford discusses the astronomical potentialities of the Cashman lead-sulfide cell, which has much higher sensitivity in the range 1.0-2.8 μ than other radiation detectors. Electronic and electromagnetic measuring, computing, and recording devices applicable in astronomy are described by Eckert. An account of some present theoretical problems capable of solution with the new high-speed computers would have been a stimulating addition to this symposium.

Almost all our knowledge of the dimensions of the stars derives from photometric observations of the eclipsing variables, which form the subject of the third symposium. In the first of the annual Henry Norris Russell lectures, Dr. Russell himself emphasizes the additional information obtainable from precise observations. The results of spectrographic studies of eclipsing binaries are summarized by Struve, particularly as these studies have led to information concerning the masses and axial rotations of the components. Shapley shows that dwarf stars like the sun show a very strong tendency to occur in close

pairs. Petrie discusses the application of spectroscopic observations to the improvement of the luminosity relation. Kopal indicates the particular importance of two unsolved problems in the theory of pairs.

The 8 papers in the symposium on the gaseous envelope of the earth will be of special interest to many scientists besides astronomers. Whipple summarizes the atmospheric data obtainable from meteor observations. Goldberg and Menzel present an hypothesis to explain the high temperature (10^6 degrees) of the solar corona. The other papers are authoritative reviews of the evidence bearing on various solar-terrestrial relationships and the hypotheses advanced to account for these relationships.

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Ophthalmology in the war years. (Vol. II, 1944-1946.) Meyer Wiener. (Ed.) Chicago: Year Book Publishers, 1948. Pp. x+977. \$16.00.

This volume is a review of the pertinent ophthalmological literature from January 1944 to June 1946. It is divided into 33 chapters, and each section is written by a different author. This feature is largely responsible for the repetition in the references by the various editors, but in spite of these minor defects this book is a valuable reference work. In it the busy practitioner can find recent advances in ophthalmology clearly outlined. The chapter on biochemistry, pharmacology, and toxicology contains much of the recent investigative work as portrayed in such a lucid fashion that it can be readily understood by the clinician. Color deficiency is briefly discussed in another chapter. Under the heading of general pathology and bacteriology a very concise review of these subjects is given. The latest thoughts on glaucoma are well presented. The chapter on injury contains a very interesting discussion on the role of trauma in detachment of the retina which points out its importance as the sole etiological factor has been overemphasized.

At the end of the discussion on surgery of the eye is found a bibliography of 1,049 articles which shows the magnitude of the task the editors had in assimilating data they presented in 35 pages. All chapters include long lists of references, a feature which adds greatly to the value of the volume. The discussion of the individual articles is often too brief to be of much help other than to stimulate the reader to go to the original source for fuller information. Therefore, this book will be of great usefulness to one reviewing any ophthalmological literature and should be in every oculist's library.

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